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ABSTRACT

This document reports the development of a system of mass-produced standardized components for school construction. The project was originated and implemented to solve a problem connected with the heavy demand for schools that confronted the Montreal Catholic School Board. The report outlines the problem -- a need for schools -- and gives details of the systematic study and research related to user needs that resulted in viable solutions to the problem on the part of 55 industrial firms that formed 11 integrated component construction systems. The means to be employed in solving the problem are detailed both verbally and graphically, showing the derivation of the performance specifications for the five subsystem components to be utilized: (1) structure, (2) heating-ventilating-cooling, (3) ceiling-lighting; (4) partition; and (5) electric-electronic services. An analysis of the solutions submitted indicated that the project goals had been achieved: (1) Reductions in the cost of school construction and in school erecting time; and (2) construction of schools capable of constantly corresponding to the development of education. (Author)

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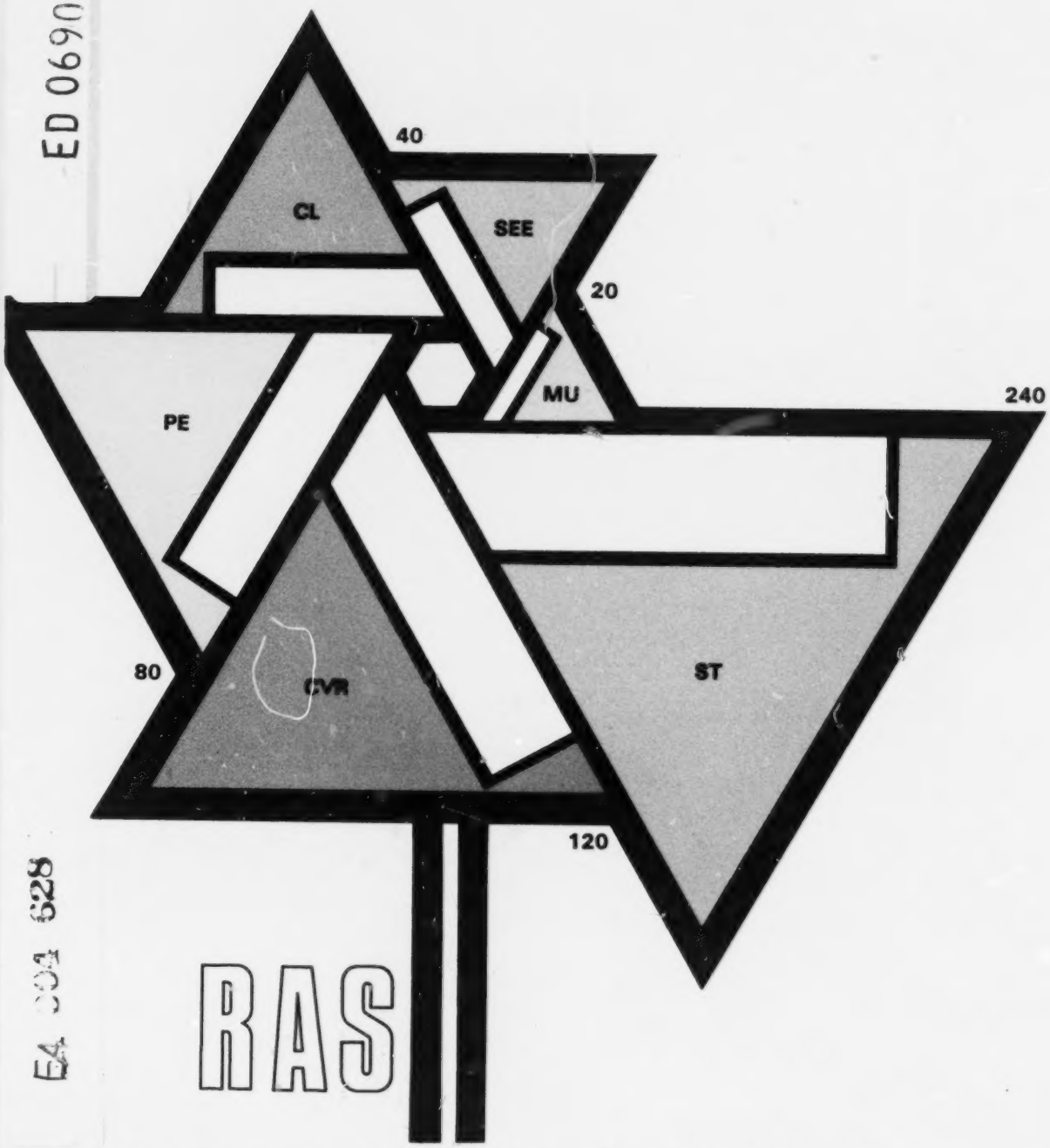


EA 003 628

# RAS

## REPORT ON THE MONTREAL CATHOLIC SCHOOL COMMISSION RESEARCH IN EDUCATIONAL FACILITIES

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MATERIALS BRANCH, DEPARTMENT OF INDUSTRY, TRADE AND COMMERCE OTTAWA

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# SCHOOL CONSTRUCTION AND NORMALIZATION

## RAS PROJECT: RESEARCH IN EDUCATIONAL FACILITIES

A project entrusted by the Montreal Catholic School Commission (MCSC) to the "Institut de Recherches et de Normalisations Economiques et Scientifiques" (IRNES) for the development of a system of mass-produced standardized components for school construction.

# INTRODUCTION

This report is published by the Department of Industry, Trade and Commerce to inform those concerned with building of a significant development in school design and construction. The report arises from a project of the Montreal Catholic School Board (Recherches en Aménagement Scolaire - Study of Educational Facilities). This project was originated and implemented as a means of solving a problem connected with the heavy demand for schools confronting the Montreal Board.

The report outlines the problem - a requirement for schools. It gives details of the systematic study and research, related to user needs, resulting in viable solutions to the problem. The means employed are detailed providing a good appreciation of such aspects of the project as the derivation of performance specifications for the five sub-system components to be utilised, namely: the Structure component, the Heating-Ventilating-Cooling component, the Ceiling-Lighting component, the Partition component and the Electric-Electronic Services component.

The project gave rise to novel organisational and contractual developments among the manufacturing and contracting companies participating as consortia groupings. New relationships within the consortia and with their architectural and engineering designers enabled the companies to mount the considerable integrated research effort imposed by the performance specifications and mandatory to tendering and bidding procedures. Thus, five series of components functionally and dimensionally coordinated within each series were offered. Each solution is described in considerable detail herein.

Much of the technological expertise resulting from the research and development work rests with these Companies, particularly with regard to joints and connections between components. The attention of the reader is especially drawn to the List of Participating Companies included as Appendix 3.

In the context of industrialized building, the R.A.S. project represents an initiative in the second generation of the evolution from the independent "closed" system toward more "open" system building. This is discernable in the report together with at least the preliminary signs of a future generation of industrialized building, which will allow inter-system utilisation of components through inter-changeability based upon functional characteristics, standardized joints and connections and dimensional coordination.

## INTRODUCTION
(cont.)

The report was prepared for the Department of Industry, Trade and Commerce by Mr. Gerard-A. Corriveau, Executive Director of the R.A.S. Project. A list of members of the Permanent Research Team assembled for the project under Mr. Corriveau's direction appears on page 6.

Because this project elicited support and cooperation from a wide cross-section of the building industry and its professions, it is virtually impossible to enumerate and acknowledge individually all those concerned. Mr. Corriveau does wish, however, that special attention be drawn to the following:

- The Montreal Catholic School Board and its Construction Division for their leadership and foresight in originating the R.A.S. Project.

- The Educational Facilities Laboratories Incorporated of New York, and the Vice President, Mr. Jonathan King of this adjunct of the Ford Foundation for a considerable financial grant and for making available much knowledge and expertise resulting from previous research and study in educational facilities.

- The manufacturers, contractors and their professional consultants for the extensive research carried out by them.

- The Department of Education of the Province of Quebec for their considerations and support in this new endeavour.

- The Materials Branch of the Department of Industry, Trade and Commerce which is responsible for the administration of the BEAM PROGRAM.

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Section 1

# THE REQUIREMENTS IN THE SCHOOL CONSTRUCTION AREA

## 1. THE CONTEXT

Educational experimentation,
Scientific discoveries in various fields,
Evolution of society,
suggest or require a search for new solutions to problems related to the development of the child.

Therefore, does the school building, whose useful life is technically at least forty years, when built in terms of the present curriculum, incur the risk of being unsuitable for requirements of the programmes in effect ten, fifteen, twenty or thirty years later.

-as per the Parent Report*

## 2. THE MCSC (Montreal Catholic School Commission)

Its requirements. Objectives. Construction Policy.

The Montreal Catholic School Commission (MCSC), at the present time, is responsible for the education of 273,000 pupils, both in elementary and high schools,

on the one hand
-in the face of population pressures within the metropolitan area,
-because of compulsory school attendance up to the age of 16 years,
-as a result of universal education,

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* Report of the Royal Commission of Inquiry on Education in the Province of Quebec.

drew up an estimate of its requirements in school facilities, and recognising present inadequacies decided on a vast construction programme for the 1968-73 period.

-financial estimate: in the range of 300 million dollars
-extent of the work: 57 new schools, 23 extensions or renovations,

on the other hand

-determined to implement the Educational Reform advocated in the Parent Report for the Province of Quebec (which involves new complicated needs),

-to express in technical terms the requirements and recommendations of educators as well as concepts defining the Polyvalent Secondary high school, among other things that of flexibility in interior spaces in relationship to one another, while strictly controlling physical environment in the buildings, in particular, air conditioning, lighting and acoustics,

-to build in a limited period of time, taking the whole of the construction programme into account,

-finally, while improving the quality and demanding new functions of the school building, to remain within the limits of the budget allowed by the Department of Education of Quebec (MEQ) and reduce maintenance costs,

decided to turn to the techniques of industrial production (plant manufacture and pre-assembly of the most important component parts, mass production, etc.), that is to the normalization of school construction.

*

This decision, which determined the general objectives of the policy to be followed, necessitated important, varied surveys: undertaking them required working methods based on scientific research procedures.

As a result, on January 19, 1967 the MCSC defined the principal objectives of the research programme to be known by the RAS symbol -"Research in Educational Facilities" - and entrusted it to the "Institut de Recherches et de Normalisations Economiques et Scientifiques"(IRNES).

This research programme, with costs amounting to about 1 million dollars, was favourably received by "Educational Facilities Laboratories", a subsidiary of the Ford Foundation, who decided to defray 1/3 of the cost of the Studies.

Section 2

# RAS PROJECT (RESEARCH IN EDUCATIONAL FACILITIES)

## 1. BASIC PRINCIPLES OF THE RESEARCH PROJECT

These principles are complementary and of two kinds:

- -on the one hand, define requirements and interpret them on the technical level,
- -on the other, cooperate closely with the building industry to adjust to its possibilities.

Since the interpretation of requirements in the technical area should result in the normalization of component parts of the school building, this would imply: the necessity

- -to discern and analyze the essential functions of the school,
- -to determine components corresponding to these functions,
- -to define the interrelationships amongst these components,
- -to promote their mutual integration,
- -to define technical criterial for each of the integrated components, as well as non-component elements.

Moreover, it was necessary:

- -to co-ordinate the endeavours of the industry in the area of prefabrication or partial prefabrication,
- -to orient the production process, while leaving the future bidder the concern and freedom to direct his studies and research for the purpose of developing methods or processes likely to produce a solution to the requirements set forth,
- -to guarantee this industry an adequate volume of production.

Starting from these basic principles, IRNES drew up the main stages in the work schedule, the various surveys to be undertaken, as well as the co-ordination of all the activities, and drew up a critical path using the PERT method.

## 2. ORGANIZATION AND METHODS

This programme comes from types of activities (pedagogical, sociological, economic, technical research) and develops in accordance with a systematic approach (investigation, analysis, synthesis).

### 2.1 The process

The research programme includes five main stages to which a certain number of activities and procedures correspond; these are:

1st stage: investigation
2nd stage: research
3rd stage: normalization
4th stage: implementation
5th stage: revision

Each of these main stages, therefore each of these relevant activities and procedures, has corresponding objectives, programmes, intermediary stages, and remarks on the means to be brought into play to succeed in the particular activity.

-"investigation level" (1st stage):
a synthesis of similar experiments, survey of maintenance problems, analysis of the Parent Report, report on school construction costs, etc.;

-"research" level (2nd stage):
analysis of school requirements, study on flexibility of spaces, analysis of physical environment criteria. (heating, ventilation, lighting, acoustics, colour, esthetics), analysis of technical calculation criteria, sociological and demographic research, economic research: capital and amortization, operation and maintenance costs..., study of modular coordination, study on the possibilities of using components, etc.;

-"normalization" level (3rd stage):
synthesis of requirements and functions, synthesis of construction and maintenance standards, preparation and writing of component specifications, determination of the construction programme of the RAS Project, development of the contract documents and procedures to be followed in the call for tenders, bids and analysis of bids, etc.;

-"implementation" level (4th stage):
presentation of bids, (January 21, 1969(, analysis of bids, awarding of contracts to the group of manufacturers whose system was accepted, construction of the pilot school (July, 1969 - January 1970), studies, verification and perfecting of the construction system, etc.;

-"revision" level (5th stage):
evaluation of the process, revision of documents, and final report. (September 20, 1971).

## 2.2 Means utilised for implementation of the program

To bring the research programme to a successful conclusion, a team of researchers was essential, and material means had to be developed or utilized.

### 2.2.1 The research team: IRNES (Institut de Recherches et de Normalisations Economiques et Scientifiques).

The IRNES Research team is called a multi-disciplinary group, including qualified professionals from each of the following fields: architecture, mechanical, electrical and civil engineering, education, economics, sociology. It has been supported by recognized consultants from outside. The coordination of it all has been secured by the Directors who have had permanent liaison with the Management Committee of the RAS Project, at the MCSC. This Board is responsible for directing the research and for advising the Commissioners of the Montreal Catholic School Commission of the decisions to be made at each of the various stages. The M.C.S.C. gives final approval to all decisions.

The Permanent Research Team:

| | | |
|---|---|---|
| Mr. Gérard-A. Corriveau | - | Executive Director of Project |
| Dr. Gaetan J. Côté | - | Pedagogical Director |
| Mr. Urbain Moreau | - | Technical Director of Project |
| Dr. Jean Durand | - | Pedagogue |
| Mr. Michel Bezman | - | Architect, co-ordinator |
| Mr. Armand Bernard | - | Engineer Economist, Systems and Procedures |
| Mr. Patrick O'Byrne | - | Architect and Town Planner, Technical Co-ordination |
| M. Louis Beauvais | - | Structural Engineer |
| Mr. Jean St-Pierre | - | Electrical and Mechanical Engineer |
| Mr. Pierre Noël | - | Mechanical Engineer |
| Mr. Jean-Louis Robillard | - | Architect |
| Mr. Pierre Teasdale | - | Architect |

2.2.2 Material means developed or utilized

The material means we have retained are many and quite varied; among the more important must be noted:

a) development of a Code of Standards for Educational facilities

b) recourse to an integrated Component Construction system

c) systematic use of modular co-ordination

d) planning of various component specifications by means of the performance specifications

e) definition of a construction program appropriate to the RAS Project

f) standardization of materials and equipment

g) establishment of particular methods for awarding of contracts.

a) Development of a Code of Standards for Educational Facilities giving the technical data corresponding to the pedagogical requirements of the MCSC by using the principles of standardization, modulation and industrialization;

This Code of Standards for Educational Facilities has been divided into three distinct books:

- A Code of Requirements and Functions,
- A Code of Construction Standards,
- A Maintenance Manual;

-The Code of Requirements and Functions to be used as liaison between educators and engineers and architects by defining, for each type of space in the school, the function which is to be served (objectives and specific activities) and the requirements this implies (area, interdependence, and flexibility of spaces - See Figs. 1, 2 and 3), corridors, necessary equipment, physical and psychological environment);

-The Code of Construction Standards which follows the Code of Requirements and Functions gives the results of the research work on modulation and normalization of materials, equipment, and technical calculation criteria; in particular, the Code defines the performance specifications of the five integrated components and sets out the directives to the various consultants entrusted with school construction;

-The purpose of the Maintenance Manual is, first, to define the inventory necessary to ensure efficient maintenance service, and second, to indicate the various periodic and preventive maintenance tasks required to reduce to a minimum major repairs for school equipment.

b) Recourse to an integrated Component construction system. The wood "Component" means a homogeneous group of interdependent units assembled and installed to serve one or several specific functions of the building. The study of problems to be solved, within the context of the RAS Project enabled us to determine five components essential to the functions of a school building (See Fig. 4), as follows:

the Structure Component (ST)
the Heating-Ventilation-Cooling Component (CVR)
the Ceiling-Lighting Component (PE)
the Partition Component (CL)
the Electric-Electronic Services Component (SEE)

The Structure Component (ST)
-designed mainly to create large spaces free of any obstruction, allowing for relocation of corridors;
-first requirement: integrate structure closely with the four other components;

Heating-Ventilation-Cooling Component (CVR)

-designed to produce a controlled physical environment conducive to the educational process;

-moreover, must permit rezoning of areas to be served and, therefore, offer great flexibility in use;

-designed in harmony with the -ST and -PE Components, this Component will offer a compact solution, result in a total integration.

Ceiling-Lighting Component (PE)

-also designed to produce a physical environment conducive to the educational process;

-must also allow for rezoning of areas to be served, and therefore, offer great flexibility in use;

-should have removeable lighting fixtures corresponding to the required performance criteria, as well as accustic finishing elements;

-component in which all the elements of the -CVR, -CL, and -SEE components are located; must ensure flexibility of the system to be developed;

-must, moreover, ensure the stability of the -CL and -SEE Components, as well as access to the services passing through the sandwich thickness;

-defined by its integration with the -ST, -CVR and -SEE Components.

Partition Component (CL)

-must, through mobility of its elements ensure flexibility of use in areas necessary for the educational process;

-must serve one primary function: visual and acoustical separation, and a secondary function: support of the vertical work surfaces;

-has to be free from limitations due to passing of electric and electronic services, since these are provided for by the -SEE Component; this separation of functions should enable the -CL Component to offer a simple economical solution.

Electric-Electronic Services Component (SEE)

-component in which the supply and distribution networks for all the electrical and electronic services are located;

-distribution in the rooms shall be done by means of "columnettes" with the same degree of mobility as the partitions;

-component of which the problems inherent in its nature should be dealt with by integration with other Components.

c) Systematic use of modular co-ordination (See Fig. 5) to facilitate the integration among various components and also to enable the other units of the school building to be incorporated into the Component system.

The horizontal integration module decided upon, a multiple of the international or standard module m=4", is equal to five 5(m) that is M= 20"; the whole of the Component system of the RAS Project therefore forms part of a modular space grid expressed by a modular integration grid consisting of a square 20" to a side. In the vertical plane, an integration module equal to 2(m), that is 8", was decided upon. The modular integration grid enables us to define a specific grid for each component with dimensions which can be those of the RAS Project modular integration grid (20" to a side) or correspond to a multiple of the horizontal and vertical integration modules.

Furthermore, various clear heights, with modular dimensions, were defined; these clear heights, four in number, are as follows: 9' 4", 13' 4", 17' 4" and 22' 0".

Finally, various sandwich thicknesses included between the under surface of the lowest ceiling element and the finished flooring of the storey above were also determined; for spans of 20', 30', 40' and 60', each group of bidders had to select a sandwich thickness from amongst the following series of modular dimensions: 24", 40", 48" or 56" and for spans of 80' amongst the following series of modular dimensions: 48", 56" or 64".

d) Development of the various component specifications by means of the Performance Specifications, which, in contrast with the traditional descriptive specifications, interpret specific requirements, raise the problems to be solved, set forth the various criteria to be respected. Through the performance specifications, manufacturers have therefore had the opportunity to select with complete freedom the technical solutions which according to them should meet the requirements set forth; in each of the books of the Performance Specifications. These were systematically planned to facilitate development and integration among components, and presented in the following manner.

Contract Documents
Intent of the Specifications
Bidding and Contract award Procedures
Function of the Component
Description of the Component
Scope of Work and Obligations
Modular Co-ordination
Design Standards:
- Dimensional criteria
- Technical design criteria
- Codes
- Performance criteria
- Tolerances
- Displacement - rearrangement
- Fire protection standards
- Aesthetics

Tests required
Integration of the five components
Co-ordination with non-system elements
Installation, erection
Guarantee
General Information Handbook
Preliminary and Final Design Proposals
Bidding

The various books of the Performance Specifications have defined in particular:

.1 for the -ST Component

Dimensions and juxtaposition of Elements (Refer to Fig. 6)

-Dimensions of elements

a) Slabs

| | |
|---|---|
| D1 | 80 ft. |
| D2 | 60 ft. |
| D3 | 40 ft. |
| D4 | 30 ft. |
| D5 | 20 ft. |
| D6 | 10 ft. |

b) Primary Beams

| | |
|---|---|
| PM | 20 ft. |

c) Secondary Beams

| | |
|---|---|
| PS1 | 40 ft. |
| PS2 | 30 ft. |
| PS3 | 20 ft. |
| PS4 | 10 ft. |

d) Columns

| | | |
|---|---|---|
| C1 | 9' 4" ) | |
| C2 | 13' 4" ) | plus sandwich thicknesses |
| C3 | 17' 4" ) | |
| C4 | 22' 0" ) | |

-Dimensions of horizontal surface elements

| | |
|---|---|
| ESH1 | 80 x 20' |
| ESH2 | 60 x 20' |
| ESH3 | 40 x 20' |
| ESH4 | 30 x 20' |
| ESH5 | 20 x 20' |

-Constituent elements of a horizontal surface:

a) slab

b) 2 primary beams 20 feet of length

c) 4 columns, one at the 4 corners of the horizontal surface. The adjacent elements can share the columns.

d) possible use of secondary beams parallel to the long axis of the horizontal surface (for example: secondary beams on the axis of the column, carrying fixed exterior walls and resting on the columns; secondary beams on and between the axis of the columns, carrying fixed interior walls and resting on primary beams; this beam would be located along the long axis of the horizontal surface.)

-In order to achieve the primary objectives of the RAS Project, maximum flexibility with the minimum variety of types of elements, a certain order of geometry would be desirable in the juxtaposition of horizontal surface elements.

The following proposed system should be considered as one of the alternative possible solutions to the requirements of the Performance Specifications.

Bidders are encouraged to propose other systems of juxtaposition, equal to or better then the one described below:

a) horizontal juxtaposition: a plan composed of a network of rectangles of various sizes; no restriction with regard to the layout of the adjoining rectangles (See Fig. 7).

b) primary beams of uniform length (20' 0"): for each horizontal surface element: possibility to have two adjacent beams, when the adjacent elements span are in the same direction,

c) a span of 10' can be obtained by placing elements at 10' intervals and spanning in the 10' direction.

-The -ST Component does not include foundations, exterior walls (however it must provide anchors and attachment systems for several types of wall: concrete blocks and brick, curtain wall...), roofing, stairs; however, bidders may propose such non-system elements, as acceptable alternatives.

.2 for the Heating-Ventilation-Cooling Component (CVR)

General Design

The -CVR Component includes mainly 2 groups of elements: assemblies and supply systems for these assemblies.

A -CVR Component Assembly means a group of elements (return grilles, diffusers, ducts, regulating elements) required to comply with the necessary distribution in maximum areas free of any permanent obstruction (vertical columns, conduits...); these areas consist of various flexible control zones. An assembly complies with the well-defined criteria of a group of rooms. Since there are several groups of rooms, there are several assemblies designated as follows: CVR-1, CVR-2, CVR-3, etc...

It is possible to have various assemblies in a specific maximum free area. However, all the assemblies required for various zones are connected to each other within a same maximum free area; the supply system is connected to each maximum free area at one or several connecting points (See Fig. 8 & 9).

There are seven assemblies required; however, this does not necessarily imply that each assembly requires a different group of elements, nor that a single group may comply with the criteria of all these assemblies.

.3 for the Ceiling-Lighting Component (PE)

General Design

The rooms of RAS Schools have been divided into four main groups according to the characteristics of their visual environment. Each group is served by a Specific Assembly, designated PE-1, PE-2, PE-3 or PE-4, which complies with well-defined criteria and includes luminaires (with tubes, ballasts and fittings), acoustical elements, light reflecting elements and fire protection elements, attachments, etc. Installation of these assemblies enables the Ceiling-Lighting to be completed from one wall to another within a given area (See Fig. 10). These assemblies are connected to secondary nodes of the -SEE Component which are the connection points of the various lighting circuits: each secondary node serves 400 sq.ft. of floor space and is located on the -PE Component grid (See Fig. 5 & 7). The ceiling part of this Component can be achieved by leaving the structure exposed, or by a suspended ceiling or by a combination of the two methods.

.4 for the Partition Component (CL)

General Design

The -CL Component which is to serve as visual and acoustical separation between two spaces, as vertical writing surface or backing for vertical writing surface, as support for various vertical working surfaces (tack boards...), and certain light equipment, should make a contribution to the flexibility of spaces in the schools by means of demountable partitions which can be installed by a crew of non-specialists along the 20"x20" grid lines.

The partitions, freed from electric-electronic limitations (support, and passage) may be formed by juxtaposition of panels, blocks, etc. with no required length, but consisting of 4" modules. All partitions shall be installed on the floor covering (tile, carpet, etc.); their head end, to be connected with the ceiling shall be able to absorb deflections of the structure. Demountable partitions shall always be used in rooms with a 9'4" clear height (regular areas). See Fig. 22.

.5 for the Electric-Electronic Services Component (SEE)

General Design

The -SEE Component which is to ensure the distribution of the electric-electronic services within the rooms, by means of mobile units called columnettes, consists of a supply network designed to ensure connection of the distribution network with the various electric panels, a distribution network ensuring the supply of the nodal junction points (primary nodes supplying equipment for columnettes and door frames, secondary nodes supplying lighting fixtures). See Fig. 12, 13, 14 & 15.

The columnettes which should offer the same degree of flexibility as the demountable partitions of the -CL Component may be in the form of a rectangular prism from floor to ceiling and shall provide for a certain number of pieces of equipment (clock, intercommunication units, light switches, convenience outlets, television outlets, etc.). See Fig. 16.

e) Definition of a construction programme proper to the RAS Project which must be large enough for the necessary investments in research to be redeemed; the programme decided on, which is to enable 21 schools to be erected (12 elementary schools, 9 comprehensive high schools), means a total floor area of 3,038,955 square feet and its implementation is to extend over a period from July 23, 1969 to December 21, 1972. The cost of the Components represents approximately 40% of the total cost for the construction of the 21 schools (elementary and secondary polyvalent) included in the RAS Project.

f) Standardization of Materials and equipment which are not part of the Component system (such standardization deals essentially with dimensional criteria and performance criteria); the standardization of these non-Component units allows for a combined order purchase technique.

g) Control of the suggested solutions by drawing up special methods for awarding contracts, according to the following procedures:

-call for Tenders for Components (July 29, 1968)
*preliminary studies by the industry

-preliminary design proposals (Oct. 15, 1968)
*verification by IRNES

-evaluation report by IRNES to the industry (Nov. 12, 1968)
*adjustments by the industry, finalization

-final design proposals, presentation of tenders (January 21,1969)
*analysis of the bids
-pre-selection
-final selection

-awarding of the contracts; conditional award
*development phase of components - tests, prototypes, manufacture

-beginning of delivery of -ST Component to the Pilot School (Dec. 12, 1969)
*Pilot school phase - Construction of the Pilot School

-completion of Pilot School and technical evaluation report (January 8, 1970)
*perfecting of components adjustment

-definitive award of contract
*construction phase - manufacture of components according to the Construction Programme

-beginning of delivery of -ST Component to the first Comprehensive High School (March 5, 1970).

Note: The dates Dec. 12, 1969 and Jan. 8, 70, March 5, 70 are subject to change.

The call for tenders, issued by the MCSC on July 29, 1968, was addressed to anyone qualified to study Component design and to ensure development, adjustment, manufacture, and installation of them.

Before delivery of the tenders, every Bidder had to submit a preliminary design proposal, which once checked by IRNES, would then enable him to perfect his Component and make the best possible use of his solution.

The 5 Components had to be combined and presented to form a distinct integrated system; since the Bidders had complete freedom to integrate with as many systems as they wished, they had to present a bid for each different integrated system in which they participated.

For each Component, each Bidder had to supply both unit prices for each of the elements forming this Component and the Total Price (Lump Sum) of his Bid. The Lump Sum allowed for comparing systems from the standpoint of cost in selecting the system to be awarded the contract; the owner and the manufacturers shall be bound by a contract based on unit price catalogues with guarantee of quantities.

Echelle 1" = 20'. D'après le plan PM 1, 2° Arch.

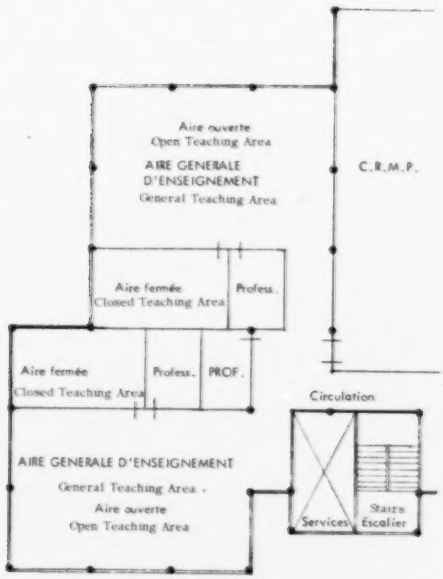



Fig. 1 Exemple de flexibilité: Aménagement des espaces selon Plan Modèle PM 1

Fig. 1 Example of flexibility: Arrangement of spaces according to Guide Plan PM 1

Echelle 1" = 20'. D'après le plan PM 1, 2° Arch.

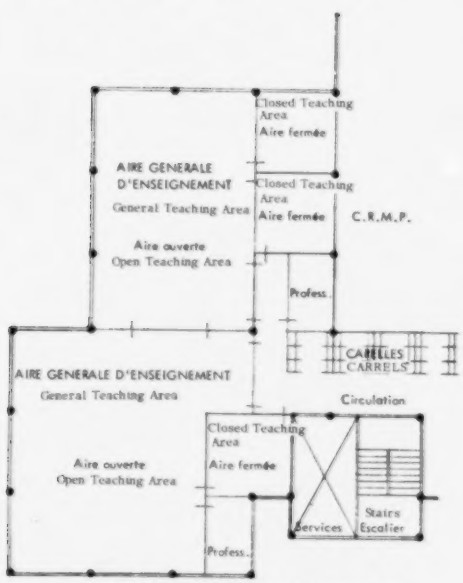



Fig. 2 Exemple de flexibilité: réaménagement des espaces – autre possibilité pour le Plan Modèle PM 1

Fig. 2 Example of flexibility: rearrangement of spaces – other possibility for Plan PM 1

Echelle 1" = 20'. D'après le plan PM 1, 2e Arch.

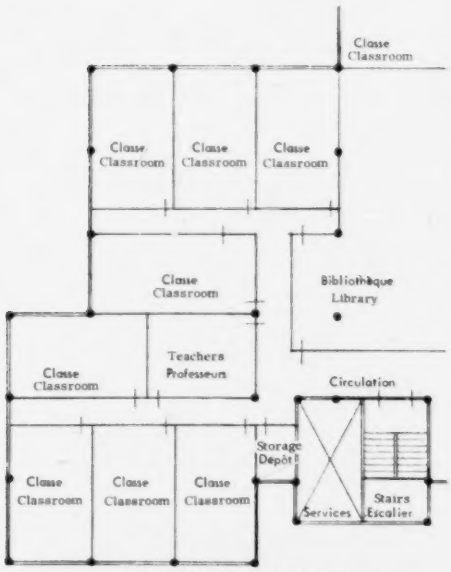



Fig. 3 Exemple de flexibilité: réaménagement des espaces en classes traditionnelles

Fig. 3 Example of flexibility: rearrangement of spaces in conventional classrooms

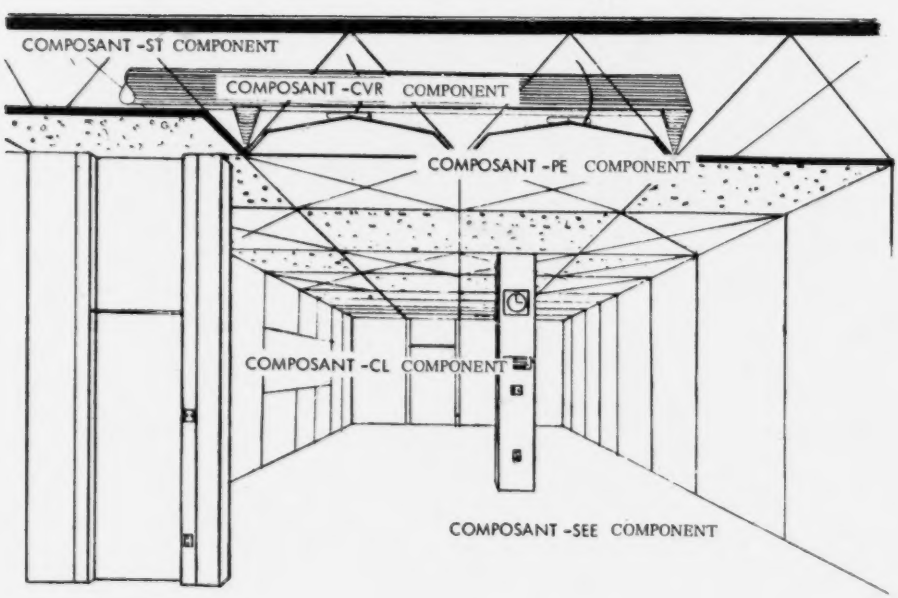



Fig. 4 Les 5 Composants

Fig. 4 The 5 Components

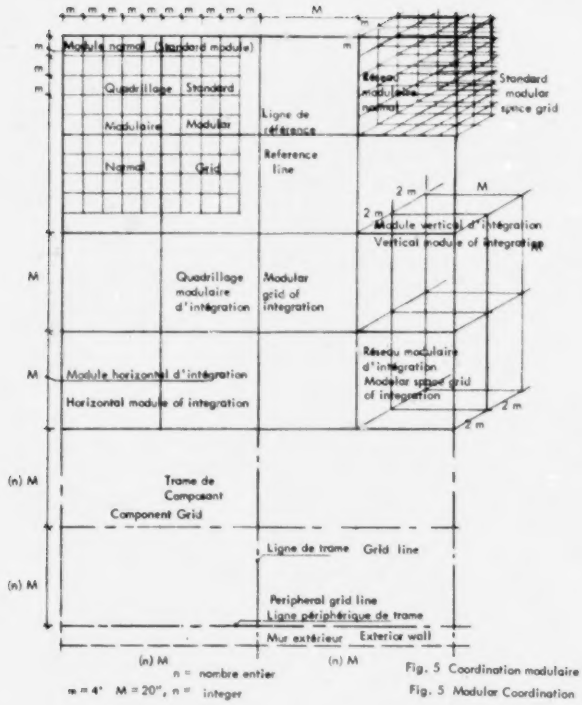



Fig. 5 Coordination modulaire

Fig. 5 Modular Coordination

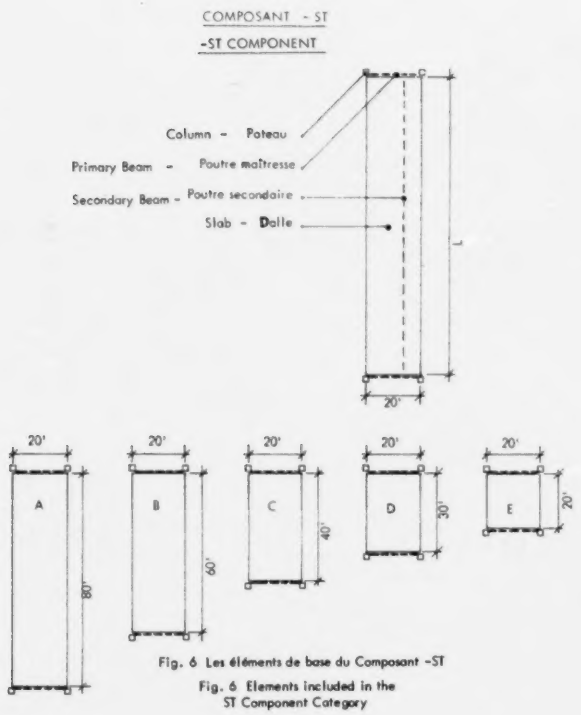



Fig. 6 Les éléments de base du Composant -ST

Fig. 6 Elements included in the ST Component Category

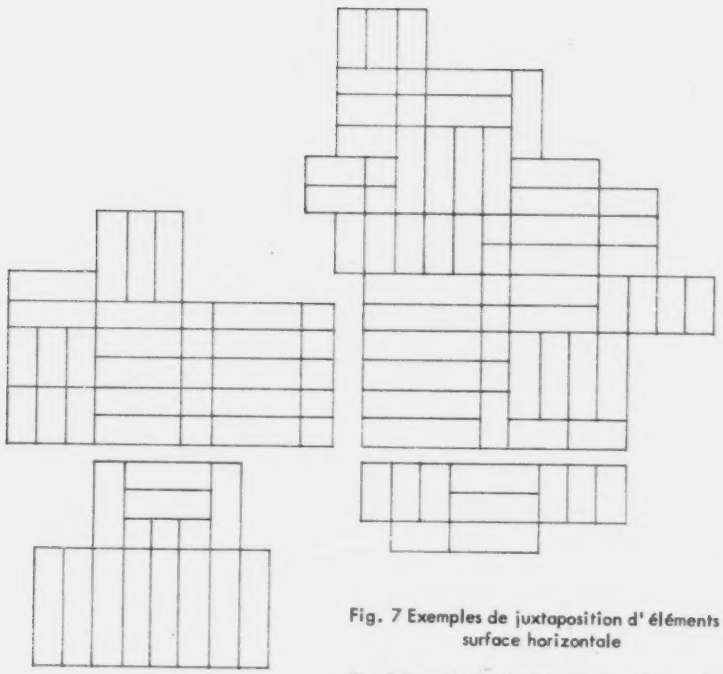


Fig. 7 Exemples de juxtaposition d' éléments de surface horizontale

Fig. 7 Examples of juxtaposition of horizontal surface elements

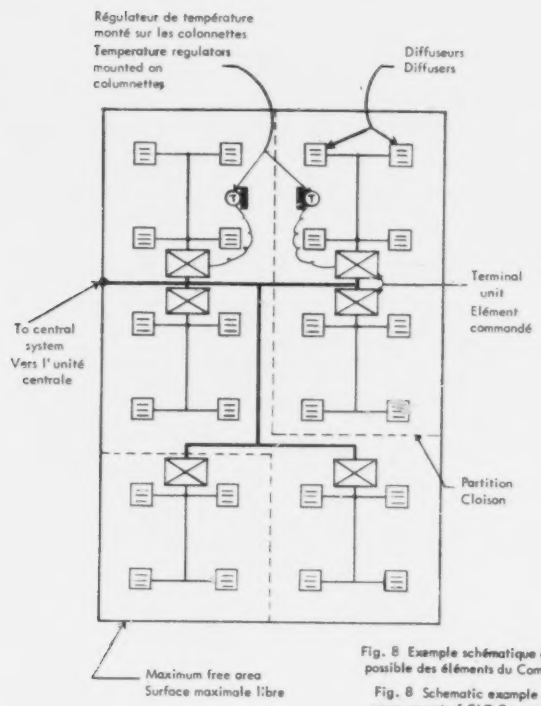



Fig. 8 Exemple schématique de disposition possible des éléments du Composant -CVR

Fig. 8 Schematic example of possible arrangement of CVR Component elements

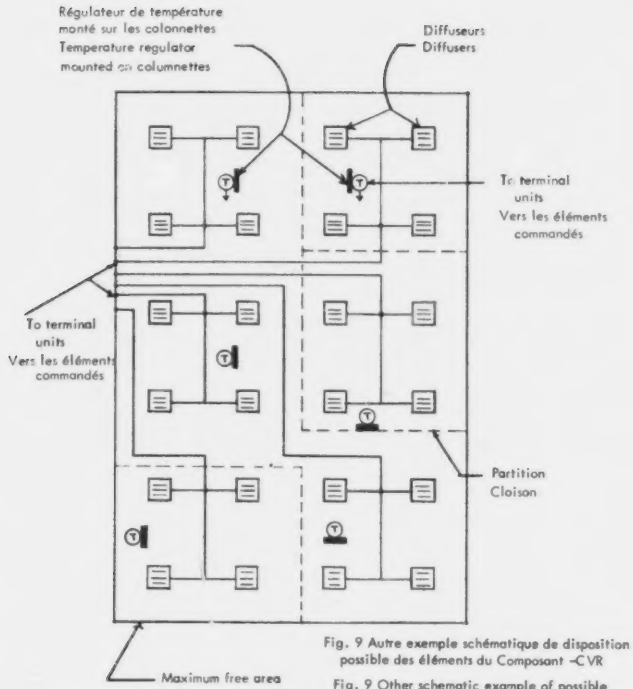



Fig. 9 Autre exemple schématique de disposition possible des éléments du Composant -CVR

Fig. 9 Other schematic example of possible arrangement of CVR Component elements

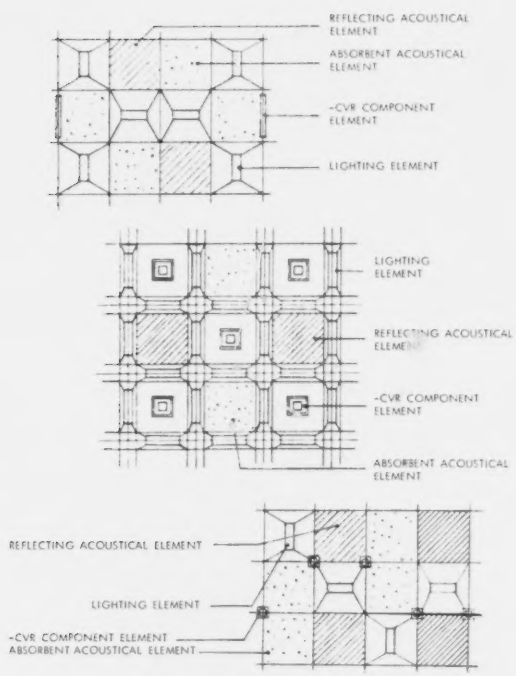



Fig. 10 Typical assemblies of CVR and PE Components at the ceiling

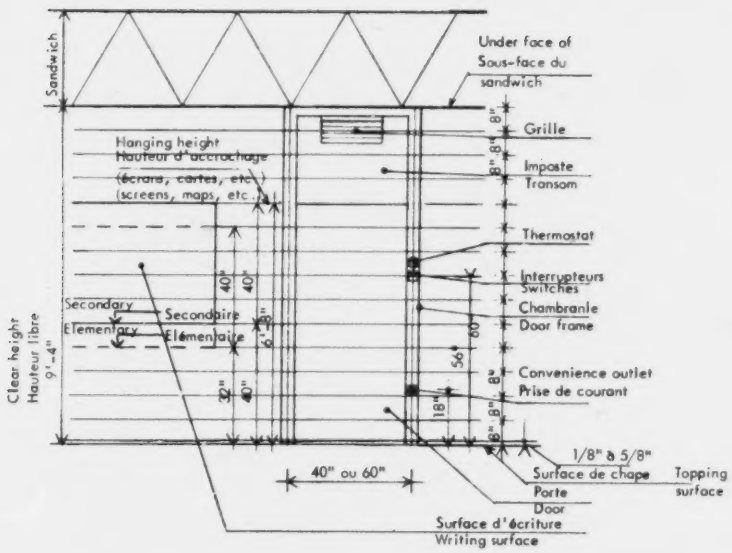



Fig. 11 Définition des différentes hauteurs des équipements du Composant -CL

Fig. 11 Specifications of the various height requirements of the CL Component equipment

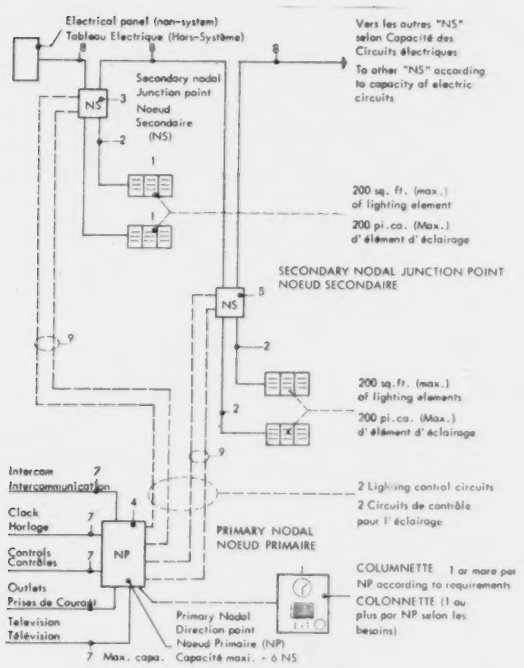



Fig. 12 Schéma de principe de Composant -SEE

Fig. 12 Schematic illustration of -SEE Component distribution network

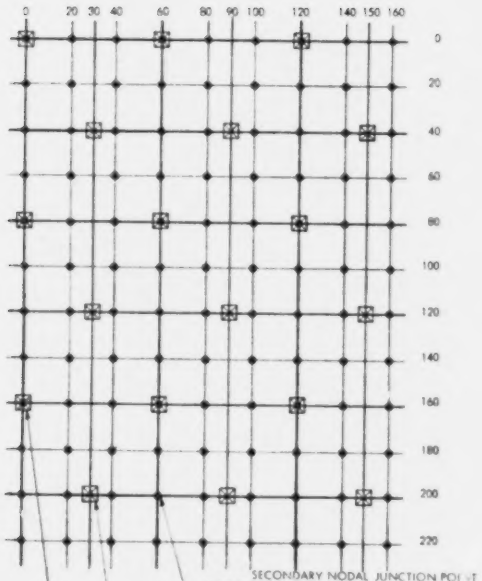



Fig. 13 Trames du Composant -SEE

Fig. 13 Implementation grid of the primary and secondary nodal junction points of the SEE Component

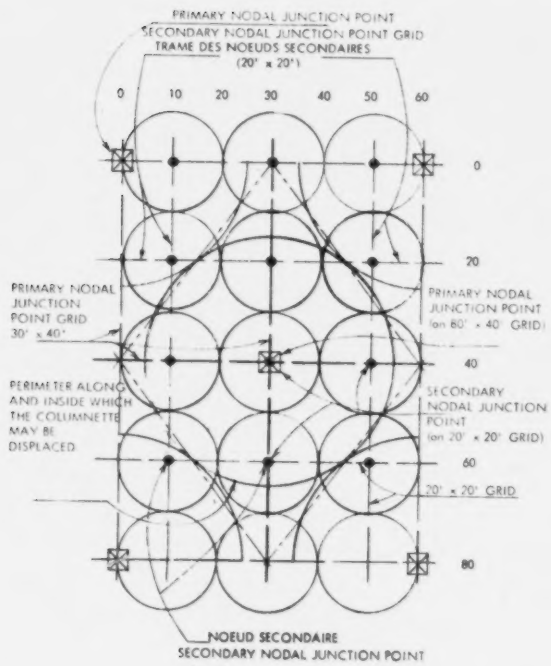

PRIMARY NODAL JUNCTION POINT
SECONDARY NODAL JUNCTION POINT GRID
TRAME DES NOEUDS SECONDAIRES
(20' x 20')
0 10 20 30 40 50 60
0
20
40
60
80
PRIMARY NODAL JUNCTION POINT GRID 30' x 40'
PRIMARY NODAL JUNCTION POINT (on 60' x 40' GRID)
SECONDARY NODAL JUNCTION POINT (on 20' x 20' GRID)
20' x 20' GRID
PERIMETER ALONG AND INSIDE WHICH THE COLUMNETTE MAY BE DISPLACED
NOEUD SECONDAIRE
SECONDARY NODAL JUNCTION POINT

Fig. 14 Detail of the SEE Component implementation grid

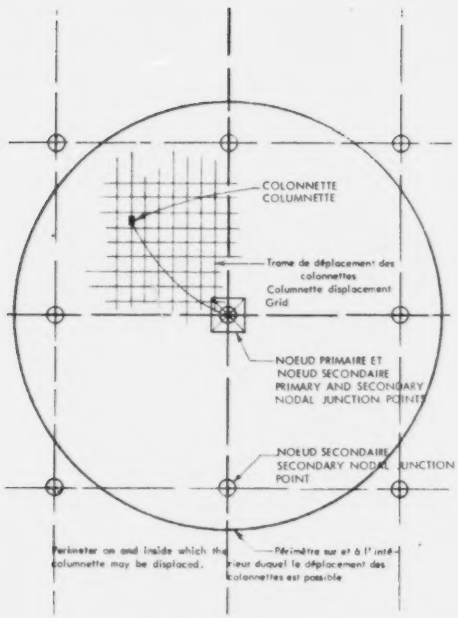
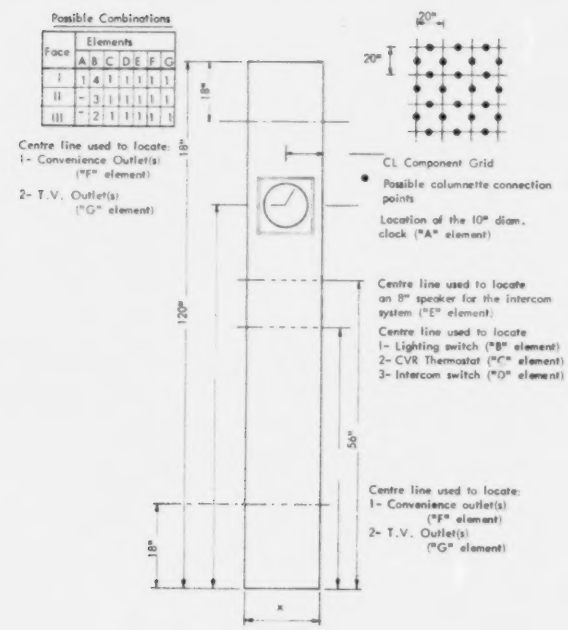

COLONNETTE
COLUMNETTE
Trame de déplacement des colonnettes
Columnette displacement Grid
NOEUD PRIMAIRE ET NOEUD SECONDAIRE
PRIMARY AND SECONDARY NODAL JUNCTION POINTS
NOEUD SECONDAIRE
SECONDARY NODAL JUNCTION POINT
Perimeter on and inside which the columnette may be displaced.
Périmètre sur et à l'intérieur duquel le déplacement des colonnettes est possible

Fig. 15
Surface de déplacement des colonnettes par rapport à un Noeud Primaire
"Columnette" displacement with respect to a primary nodal junction point


Possible Combinations
Face
Elements
A B C D E F G
I 1 4 1 1 1 1 1
II - 3 1 1 1 1 1
III - 2 1 1 1 1 1
Centre line used to locate:
1- Convenience Outlet(s) ("F" element)
2- T.V. Outlet(s) ("G" element)
18"
18"
120"
56"
18"
20"
20"
CL Component Grid
Possible columnette connection points
Location of the 10" diam. clock ("A" element)
Centre line used to locate an 8" speaker for the intercom system ("E" element)
Centre line used to locate
1- Lighting switch ("B" element)
2- CVR Thermostat ("C" element)
3- Intercom switch ("D" element)
Centre line used to locate:
1- Convenience outlet(s) ("F" element)
2- T.V. Outlet(s) ("G" element)
x

x is to be determined by the Bidder

Fig. 16

Specifications of the various height requirements of the "columnette" equipment

# 3. INTEREST AROUSED BY THE RAS PROJECT AND RESULTS OF THE CALL FOR TENDERS

## 3.1 The Building Industry and RAS Project

Thought of in terms of Quebec Industry the RAS Project, and especially the Contract Documents and the Performance Specifications, enabled manufacturers:

- -to have a better understanding of current problems raised by school construction;
- -to undertake research and give direction to their studies;
- -to join into working groups in order to present coherent solutions, perfectly adjusted, which meet the requirements of the MCSC construction programme.

The RAS Project, on the other hand, through standardization of materials and Components, planning of construction programmes and coordination of all operations in manufacture, delivery and installation, brings to the manufacturer the corresponding factors of security such as:

- -forecast of the market,
- -guaranteed volume of orders,
- -staggered production,
- -reduction of stock.

## 3.2 Professionals and the RAS Project

The architects and engineers engaged by the MCSC for the construction of a school shall assume the same responsibilities as for traditional work; in fact, their role, a decisive one in shaping plans and specifications for the schools, will be facilitated by the use of an integrated component system which, while allowing for great freedom of design, offers means for making decisions with regard to their professional responsibilities.

A document, entitled "Directives to Consultants" has been provided for in the context of the RAS Project, in order to ensure that the professionals should secure all the possible advantages from the successful system. Furthermore, the professionals will have a "General Information Handbook" on hand, supplied by the Component Contractor for each system, collecting all the technical information and data about the system as well as the full range of options and available alternatives with their characteristics.

Finally, the application of modular coordination to the construction of the whole school, will enable professionals to have better control over all construction elements, components and non-system elements.

## 3.3 Bids presented

The RAS Project aroused a great interest in industrial circles; at the opening of the bids at the MCSC on January 21, 1969, fifty-five bids had been submitted and, through compatible permutations, formed eleven integrated Component Construction systems.

Structure Component (ST):

two solutions in prefabricated concrete
(Francon Ltée., Services SNC Limitée)

two solutions in steel
(Dominion Bridge Co. Limited, Canron Limited)

one solution in concrete poured on site
(Janin Construction)

Heating-Ventilation-Cooling Component (CVR):

| | |
|---|---|
| Lennox Industries | 1 bid |
| American Air Filter of Canada | 3 bids |
| Dominion Bridge Co. Limited | 3 bids |
| Services SNC Limitée | 1 bid |
| Canron Limited | 3 bids |

Ceiling-Lighting Component (PE):

| | |
|---|---|
| Electrolier Corporation | 1 bid |
| Canadian Johns Manville Co. Limited | 9 bids |
| Services SNC Limitée | 1 bid |

Partition Component (CL):

| | |
|---|---|
| B.K. Johl Inc. | 4 bids |
| Canadian Johns Manville Co. Limited | 3 bids |
| Atlas Asbestos Co. | 3 bids |
| Services SNC Limitée | 1 bid |

Electric-Electronic Services Component (SEE):

| | |
|---|---|
| Bédard-Girard Limited | 1 bid |
| Namur Equipement Limitée | 6 bids |
| Dominion Bridge Co. Limited | 3 bids |
| Services SNC Limitée | 1 bid |

After an analysis of the solutions submitted, we can assert that the triple purpose set by the promoters of the Project had been achieved, that is:

- reduction in the cost of school construction by mass production of the school building elements;
- reduction of school erection time through the use of prefabricated components;
- construction of schools capable of constantly corresponding to the development of education - that is, transformable, with high technical quality and optimum performance.

The following paragraphs set forth the results obtained in detail.

### 3.3.1 Quantitative Results

The use of an integrated Component System will enable us to the achievement of substantial savings. After analysis, the unit price per square foot of the components submitted by the lowest Bidders is $5.29, by comparison with the actual price of $6.07 for traditional school construction in Montreal, and the target-price of $5.63 set by the standardized budget of the Department of Education for the whole of the Province.

The cost of the non-system elements has been estimated at $8.87 per square foot of floor area; under such circumstances, the cost of school construction in Montreal for the whole of the Construction programme including 12 elementary and 9 comprehensive high schools will be about $14.16 per square foot of floor area. Therefore, the cost of the RAS Project schools will be distinctly below the expenditure ceiling authorized ($14.48) by the DEQ for such a programme, in spite of the fact that construction costs are higher in Montreal than the average for the rest of the Province because of higher labour costs and specific requirements of the Fire Protection Code of the City of Montreal.

Moreover, it is thought that prefabrication and mass production of materials and components will enable school erection work to be accelerated by about one month in the case of elementary schools and from two to three months in that of comprehensive high schools.

Therefore, it is considered that the economic imperatives have been satisfied; in fact the purpose of the project was not to make startling reductions in costs to the detriment of quality, but rather the rational use of available resources (budget, industry possibilities..) for better schools at an acceptable price.

### 3.3.2 Qualitative results

From the viewpoint of quality all the proposed systems enable us to assert that the manufacturers have done particularly significant work in adapting to the principles - entirely new for them - of the Performance Specifications.

They have all applied themselves, quite obviously to a varying extent, to adopting their working methods and carrying out research both at the level of studies in development of their Components, and at that of integration of each Component into the overall system -which is more difficult and more complicated.

None of the proposed solutions, that is the 11 Systems, is actually to be rejected: with the exception of a few particulars, all comply with the Performance Specifications. However, since some submit either new products or equipment, especially designed for the RAS Project, or original installation procedures, these are of the greatest interest and truly reveal the importance and credit the construction industry of the Province of Quebec has attributed to the Project.

The group of bidders whose offer has been rated as the most advantageous are grouped around the Francon Company Limited, supplying the Structure (ST) Component; the others are:

| | |
|---|---|
| -Heating-Ventilation-Cooling (CVR): | Lennox Industries |
| -Lighting-Ceiling (PE): | Electrolier Corporation |
| -Partition (CL): | B.K. Johl Inc. |
| -Electric-Electronic Services (SEE): | Bédard-Girard Limitée |

### 3.3.3 Joints

Since some patents have not as yet been obtained all explanatory wording and details concerning the joints has been withdrawn from this presentation at the request of the manufacturers.

## 3.4 Methods of Expression (description of Systems)

The order used to describe the Systems corresponds to that established at the time of classification according to Total Unit Prices (in $/sq.ft.) after applying Correction Factors.

### 3.4.1 Francon Group System

The System consists of:

| | |
|---|---|
| Francon Limitée | for the Structure Component |
| Lennox Industries (Canada) Ltd | for the Heating-Ventilation-Cooling Component |
| Electrolier Corporation | for the Ceiling-Lighting Component |
| B.K. Johl Inc. | for the Partition Component |
| Bédard-Girard Limitée | for the Electric-Electronic Services Component |

Coordinator for the Francon group: Robert Hughes Associates (Management) Limited.

The System is based on a prefabricated concrete Structure (prestressed slabs and portal frames).

The proposed solution offers a sandwich thickness of 48" in all the areas.

(The texts are excerpts from the General Information Handbook and the Final Design Proposals).

a) Structure Component (ST) -Francon Limitée-

a) .1 General Characteristics

In order to arrive at the proposed solution, the purpose has been to supply a system composed of simple elements lending themselves to a limited number of layouts. This uniformity, combined with a volume determined in accordance with an established construction schedule, will allow for a more economical use of our production and installation resources.

The solution, using prefabricated concrete for the -ST Component, consists mainly of vertical portal frame elements 20' wide, one storey high, supporting prestressed concrete slabs of the double T type, with a width of 10' and a variable length. Every space enclosed between four grid lines of the -ST Component constitutes a separate volume, structurally independent.

The topping provides structural continuity between the various volumes. Requirements for exterior wall treatments, are satisfied by means of a series of column and beam elements. The long span slab elements have been decreased in width and/or increased in depth for the purpose of meeting design and handling requirements. Only the slabs are prestressed.

-The system consists of two basic parts:

1) double T or single T slabs

2) single or double portals

-These units may be arranged so that the volume elements may generally be 20' wide by 20', 30', 40', 60' or 80' long, with a clear height of 9'4", 13'4", 17'4" or 22'0".

-The volume elements may be combined in such a way that adjacent units are parallel or perpendicular

-When the general layout justifies it, the portal framework will be of double thickness and will support the ends of the slabs.

a) .2 Detailed description of Structural Elements

The -ST Component includes four (4) distinct categories of elements:

a) Horizontal Slab Elements
b) Vertical Portal Frame Elements
c) Peripheral Column Elements
d) Peripheral Beam Elements.

The above categories are further subdivided into various types by:

a) the variable lengths of horizontal surface elements,
b) the variable storey heights,
c) the various structural dead load and live load requirements.

Category "A" Slabs

-In category "A", there are seven (7) different horizontal surface elements.

| | | | | | |
|---|---|---|---|---|---|
| 1) | 10' | x | 80' | x | 48" |
| 2) | 5' | x | 60' | x | 24" |
| 3) | 10' | x | 40' | x | 24" |
| 4) | 10' | x | 30' | x | 24" |
| 5) | 10' | x | 20' | x | 24" |
| 6) | 10' | x | 10' | x | 24" |
| 7) | 10' | x | 20' | x | 9" (mechanical rooms) |

The double T slabs 10' 0" wide, and 10' 0", 20' 0", 30' 0" or 40' 0" long, form with the single T slab either 5' 0" wide and 60' 0" long or 10' 0" wide and 80' 0" long, all combinations of horizontal free surfaces required.

For the 60' 0" span, the single T slabs are 5' 0" wide for ease of handling.

On all slab elements, except roof elements, a 2" thick concrete topping, will be placed on site, as an integral part of the structure. The roof slabs will receive a 1" thick concrete topping for levelling purposes.

The vertical ribs of the double T slabs are centred 2' 6" from the longitudinal edge; as a result, in a typical 20' 0" wide area, there are four (4) ribs with 5' 0" spacing between their centres.

Double T slabs carry welded plates at points of contact with portal frames.

Provision is made for attaching supporting units of the -PE and -CVR Components to the underside of vertical ribs (with the exception of 80' 0" span slabs) at 5' 0" intervals, beginning 2' 6" from a grid line of the structure in either direction.

The solution offered provides, as an additional characteristic, a special slab, 20' x20' (with a central opening) for each of the mechanical rooms at each level. This slab, achieved by means of 2 perforated thin triple T slabs, is supported by the same portals as those supporting other slabs. The floors are at the same level as adjacent system areas. The same free height for the passage of.

non-system elements horizontally is observed for the passage of the air intake and exhaust shafts.

Peripheral columns and beams have been provided at all levels of the structure, to carry various combinations of exterior wall treatments.

Another additional characteristic: Concrete sandwich panels (of various sizes) are available, If these prefabricated sandwich panels are used for the exterior wall, only a few peripheral beams will then be required.

Category "B" Portal Frames

-Category "B" includes three portal frames types: two (2) single and one (1) double. The single portal frames are 12" thick with outside dimensions of 20' 0" and 10' 0" respectively. The double portal frame is 24" thick with an outside dimension of 20' 0". The 20' 0" types have six possible clear heights: 13' 4", 17' 4", 26' 0", 21' 4", 26' 8" and 30' 8". The 10' 0" type has three possible clear heights: 13' 4", 17' 4" and 26' 8".

-Each one of these 15 types has been designed to carry anyone of th seven (7) types of horizontal surface elements, by varying the reinforcement steel. The portal's cross sectional dimensions taken at its beam or column remains constant.

The vertical members of the portals include two (2) columns and a beam which will be cast monolithically in a limited number of types of steel forms.

In order to reduce the size of the elements for transport purposes, the portal frames with clear heights of 17' 4", 21' 4", 26' 0", 26' 8" and 30' 8" could be cast in separate parts, the columns being separate from the beam. This restriction will apply to about 25% of the quantity of the portal frames.

The portal frames are placed directly one upon the other to the required height, using a temporary dry connection, grouted after all structural elements are erected.

The portal frame columns are constant in section and measure (nominally ) 12" x 12" on plan.

Each beam of the portal frame measures (nominally) 12" (or 24") wide 30" deep x 20' long. The 20' beam is perforated by three openings: 40" x 8" openings with their centre 5' from the outer face of the columns, and one 40" x 16" opening centered between the columns. All the openings are located 7" below the top surface of each beam.

Portal frames carry welded plates at points of contact with tee slab ribs.

When connected, two portal frames and the associated tee slabs form a rigid four legged structure.

These elements may be arranged to form various volumes with groups of 1, 2, 3, or 4 columns, without any restriction.

Category "C" Peripheral columns

-Category "C" includes 7 peripheral column elements, designed to carry the four types of exterior wall treatment, with no restriction as to their location.

The length of these elements varies according to the various clear heights used for the 21 schools.

The columns are of standard cross section, measuring (nominally) 12" x 24".

These columns are spaced 20' apart from centre to centre and occasionally 10' apart.

The outer face of the columns will lie on the structure grid line.

To allow the columns to pass, openings 12" x 24" will be available through the horizontal surface elements.

Columns will be attached to the flanges of the horizontal slab elements as required for lateral stability.

Category "D" Peripheral Beams

-Category "D" includes three (3) types of peripheral beam elements offering all combination of support for the four types of wall treatment specified, whatever their combination or location.

The use of prefabricated concrete panels (Francon) would eliminate the peripheral beams.

The beams are of standard cross section, measuring 8" x 30".

The length of the beams is either 20' or 10'.

The beams may be located with either their interior face or their centre line on the structure grid line.

The beams will be connected to the peripheral column elements, and the exterior portal beams, by means of welded or bolted connections, according to specifications.

a) .3 Additional Notes on the Component

Lateral forces:

The proposed solution provides for lateral forces to be transmitted to non-system stair and/or mechanical room cages, with the exception of gymnasia for which the structural elements are designed to resist lateral forces and transfer the loads to the foundations.

Every space element included within the four structure grid lines, constitutes a separate independent volume. These volumes are made monolithic by the 2" structural topping, which also transmits lateral forces to the cages.

Floor loads:

All the structural elements have been designed to carry all live load and dead load conditions required by the specifications.

Live load on the stairs:

Peripheral columns and beams have been provided for around the edge of the stair wells.

For the horizontal surface elements, provision has been made for an additional 200 lb. load located at the centre of each rib in the slabs at 5' intervals beginning 2'6" from any structure grid line. This additional load covers the requirements of the -PE and -CVR Components.

The structure also takes the weight of mechanical equipment into account, as determined by the -CVR Component.

Element volume Combinations:

Combinations from categories "A" and "B" offer the following possibilities of space enclosure in terms of different volume arrangement. There are four variables in height, two in width and five in length for spans up to 60' inclusive. For 80' spans, there is one constant in width, one in height and one in length. As a result there are 40 combinations possible for spans up to 60' inclusive and one combination possible for spans of 80'. Each horizontal surface element is supported by two portal frame elements making one element volume. The system is designed so that element volumes are independently stable. Element volumes may be erected in a horizontal or vertical sequence without interruption. However, at all floor levels other thatn the first, the two columns of the portal frame must be on the same axis as the columns of the one immediately below, since the superimposed portal frames are in the same plane.

Element volume connections:

The temporary dry connection joints between the superimposed volumes, and element volumes and foundations are structurally adequate, for the complete erection of the building.

Grid lines and openings:

The -ST Component Grid line constitutes the plan boundary of any element volume. The perimeter of openings in the structure for mechanical rooms, staircases or other, must coincide with the -ST Component grid lines.

Mechanical openings:

Special slabs for mechanical rooms are to be located with their perimeter always a minimum distance of 40' from the perimeter of the building and are to be generally located centrally within the distribution zone served by the mechanical room.

Extension of the system:

There is no limit to the horizontal extension, since each volume is stable and independent. Vertical extension is possible above the four levels stipulated, but each case should be analyzed individually because of the limitations imposed by the structure and by the erection equipment.

Production-Erection:

Elements will be manufactured at the pre-stressed concrete plant of Francon Company Limited, 8300 Pie IX Boulevard, Montreal.

Considering a typical school, plan the following sequence of production. From the professionals' drawings, a drawing showing the layout of structural elements will be prepared and submitted for approval. A take-off of all the structural elements will then be made from the approved drawings. Then a production schedule will be drawn up for the elements not already in stock. The production will then be scheduled, taking several factors into account; for example, the time required to get the production started.

The production time in the strict sense of the word includes:

Inventory of the finished elements, and the time available to complete the programme. When possible, production of identical elements will reach a maximum. The steel reinforcement cases will be manufactured in series before pouring. Special templates will be used for bending the rods to ensure an accurate assembly.

Special attention will be paid to the manufacture of the steel forms to avoid deterioration throughout the duration of the contract.

The concrete elements will be manufactured on a daily basis. Floor and roof slabs will be cast on long-line beds. On the following day, the units taken away from their moulds, will then be inspected and transported to the stocking area where they will be stock piled until called forward for delivery to the job site.

Production will be scheduled to maintain a rate of production at a generally constant level for as much of the programme as possible. The stock will be maintained at a level sufficient to accomodate the demands from the erection department while respecting the time stipulated for curing of the units. On the basis of the programme supplied the productive capacity will be allowed for some 33,000 square feet per week.

Erection schedule:

It should be noted that the structure is erected from volume elements forming bays, either horizontally or vertically.

The temporary dry connection joints between columns are structurally adequate during the erection period of the construction loads, before the grouting of these joints is completed.

The erection will scheduled as follows:

1) Erect two portal frames forming a bay (or volume element) and stabilize them temporarily.
2) Erect floor elements and weld the shear connectors and also bearing plates.
3) Complete the column joints (grouting)
4) Erect the peripheral columns and the peripheral beams.
5) Lay the concrete topping.
6) Remove the temporary stabilizing supports.

It is estimated that the erection of a Polyvalent Secondary school will be completed within 20 weeks and an elementary school in less than 4 weeks. If possible, these periods of time will be further decreased by employing a second erection crew.

b) Heating-Ventilation-Cooling Component (CVR)
Lennox Industries (Canada) Limited

b) .1 General characteristics

The CVR Component, a multi-zone type, includes the following elements:

-the air handling units, located in the mechanical rooms (20' x 20'),
-the distribution ducts (3 sizes 18" x $7\frac{1}{2}$", 14" x $7\frac{1}{2}$" and 10" x $7\frac{1}{2}$"),
-diffusers,
-thermostats.

The maximum space which can be served by the equipment located in a mechanical room is approximately 16,000 sq.ft.

The mechanical rooms, located as close as possible to the centre of the zones to be served, will always be superimposed.

Each mechanical room has two adjoining vertical air shafts, located at the centre, one for distributing fresh air, the other for exhausting the stale air.

Within each mechanical room, it is possible to have one or two ventilation units. Each unit consists of a mixing box with fresh air intake dampers, air return dampers and stale air dampers, filters, distribution fan, hot water coil, cooling coil, return fan and humidifier.

The air distribution system (or distribution unit) with hot and cold decks laid out around the two shafts, in the form of a squared doughnut, is above the ventilation equipment. On each side of the distribution unit there are three mixing boxes, arranged in such a way that they are aligned with three openings in the girder of the 20' portal of the -ST Component.

The air distribution ducts are located both between the ribs of the slabs - then they free the portals by means of the three openings provided for this purpose, - and under the ribs of the slabs, at right angles to the others.

Air is diffused between the -PE Component elements by means of diffusers integrated with the units of this Component, since these diffusers are located on a 10' 0" grid line, shifted 5' 0" from the grid lines of the -ST Component. However when the layout of the small parts requires a different location of the diffusers from that described above, shifting of these is possible.

The diffusers are of a linear type, the edges of the frames of the -PE Component units, combined with a cover and a upright part, forming a diffusion capsule.

Connections of the diffusers to the ducts are made at the junction of four -PE units by means of a central square connector box which can allow for distribution of the air in each of the four directions.

The sides of the connector box may be closed whenever air diffusion is not required in a particular area.

Air is returned through the space left between the -ST Component slab and the -PE Component ceiling; none being returned through grills placed in the transoms of the doors or in the walls.

The room thermostats are located in the plenum at the places where the return air passes through the connecting elements of the -PE Component units.

b) .2 Installation

Each ventilation unit, controls included, is assembled in the plant. The humidifier and return fan are shipped separately. The central unit, shipped in one piece, is bolted to one of the special slabs of the mechanical rooms and then raised with the slab and set in place.

The distribution ducts are supported by the stirrups of the -PE Component units for the lower layer, by the support rods attached at each end of the adjustable attachments of the same stirrups for the upper layer, between the ribs of the double T slabs.

c) Ceiling-Lighting Component (PE) -Electrolier Corporation-

c) .1 General characteristics

The -PE Component is formed by a combination of ceiling elements (coffer frame) and lighting fixtures set in place according to grid lines 5' 0" to a side.

These grid lines coincide with the 5' 0" grid lines of the -CVR Component diffusers. Every -PE Component fills a $58\frac{1}{2}$" x $58\frac{1}{2}$" square within the grid lines. The $1\frac{1}{2}$" space between each unit is designed to accommodate either the heads of the partitions and columnettes, or -CVR Component air diffusion units.

Each -PE Component unit is suspended individually at the centre by means of a stirrup attached by means of a simple adjustable attachment on the underface of the flanges of the -ST Component double T slabs.

The PE Component which allows for air diffusion and return is used to support the ducts, diffusers, thermostats of the -CVR Components, as well as the Secondary Nodes of the -SEE Components.

Each -PE Component unit may be illuminated by installation of one or two tube lighting elements with or without a screen, or not be illuminated and then form a horizontal surface; in fact since the lighting fixture is recessed inside the coffer frame and has on both sides a fire-proof, acoustic, absorptive or reflective panel, when the unit does not contain a lighting fixture the panels are lowered to form a flat horizontal surface. Every lighting fixture is connected with a Secondary Node supplied by the -SEE Component.

In order to allow for a 20" possible displacement of the demountable partitions of the -CL Component and the Columnettes of the -SEE Component ("clip in") type 2 -edge rails with profile identical to the frame are provided for installation within the 60" x 60" module of the -PE Component.

By using the same rails, 2/3 of the module may be either illuminated, or covered with a sound-proof panel.

As far as finishes are concerned, every painted metallic component is first dipped in a hot iron phosphate solution, then covered with a coat of baked enamel, every non-painted component is either galvanized or cadmium plated; pressed mineral fibre acoustic panels are painted with white washable paint.

c) .2 Method of assembly, installation

The frames will be delivered in separate pieces; once the four sides are riveted together and the stirrup set in place, each of the frames will then be raised and the attachment at the upper end of the stirrup secured to a screw bolt set in place for this purpose on the double T slab flanges.

The adjoining frame is assembled in the same manner, raised, adjusted and secured. A cross-shaped support is installed at the intersection of the two frames. The $1\frac{1}{2}$" space between the frames is filled by means of interlocking conduits.

The independent lighting elements have end plates at each end and the unit, installed in the frame, rests on two shoulders.

The lighting fixture is connected to a Secondary Node of the -SEE Component by means of a group of BX, 120V cables and is enclosed by two acoustic panels which rest on the upright plates and the two free shoulders.

d) Partition Component (CL) -B.K. Johl-

d) .1 General characteristics

The -CL Component consists of:

-panels composed of two sheets of rolled steel finished with a baked enamel surface and interior lead sheeting for partitions.

-panels of the same composition with a special paint finish C.P.I. Duracron 500, full height from writing surfaces (with chalk tray).

-uprights used to join the panels,

-mouldings,

-floor and ceiling rails in laminated steel,

-door frames.

Suspension rails for maps, diagrams, tack boards and special acoustic panels will be installed by means of adhesive with 2 sticky surfaces.

The normal length of the panel is 5' 0" from centre to centre of the moulding, however, the 20" and 40" panels have been provided to satisfy the installation requirements, for the doors, as well as appropriate length panels for all adjustments to columns and non-system walls.

The height of panels (head and base included) is 9' 4".

The partitions are located on the 20" x 20" grid lines coinciding with certain -ST and -PE Component grid lines.

Each panel as well as each face of a panel may be installed or demounted individually without disturbing the adjoining panels.

The uprights, which allow for connecting panels in one, two, three or four directions may be electrified when necessary. The electrified uprights will allow for access to the wiring by simply removing the electrical mouldings with convenient outlets and switches. The electrified uprights will be connected directly to the Primary or Secondary Nodes of the -SEE Component.

d) .2 Installation

The panels, delivered to the site in cardboard wrappings, weighing 4 lb/sq. ft., may be installed by a crew of non-specialized men.

The ceiling rails will be attached between the -PE Component Units by means of hidden fixtures; the floor rails installed with

the aid of a plumb line will be attached to the finished surface (tile or carpet), by means of a two side adhesive (leaving no trace on dismantling).

The panels will be inserted in the upper and lower rails (the horizontal level being established by means of shimming) and attached to the uprights by means of bolts, then the moulding will be set in place.

Joints of inorganic light-and-sound proof cellular material will be installed at all points of contact with the building (structure, non-system exterior wall, interior wall).

e) Electric-Electronic Services Component (SEE) -Bédard-Girard-

General characteristics

The -SEE Component consists of:

-primary nodes supplying the various equipment mounted on the columnettes and the switches located on the electrified upright of the -CL Component,

-secondary nodes (2 types) used to connect lighting fixtures of the -PE Component, those which are non-System, the convenient outlets on the electrified uprights of the -CL Component and, where there is need, to switches situated in the door frames,

-the columnettes (2 types) which can accommodate the stipulated equipment (clock, intercommunication unit, four switches, 2 electrical outlets, 1 television outlet),

-the network of empty conduits (supply network linking the distribution network with the various lighting panels, T.V. network linking the Primary Nodes with panels or junction boxes, intercommunication network).

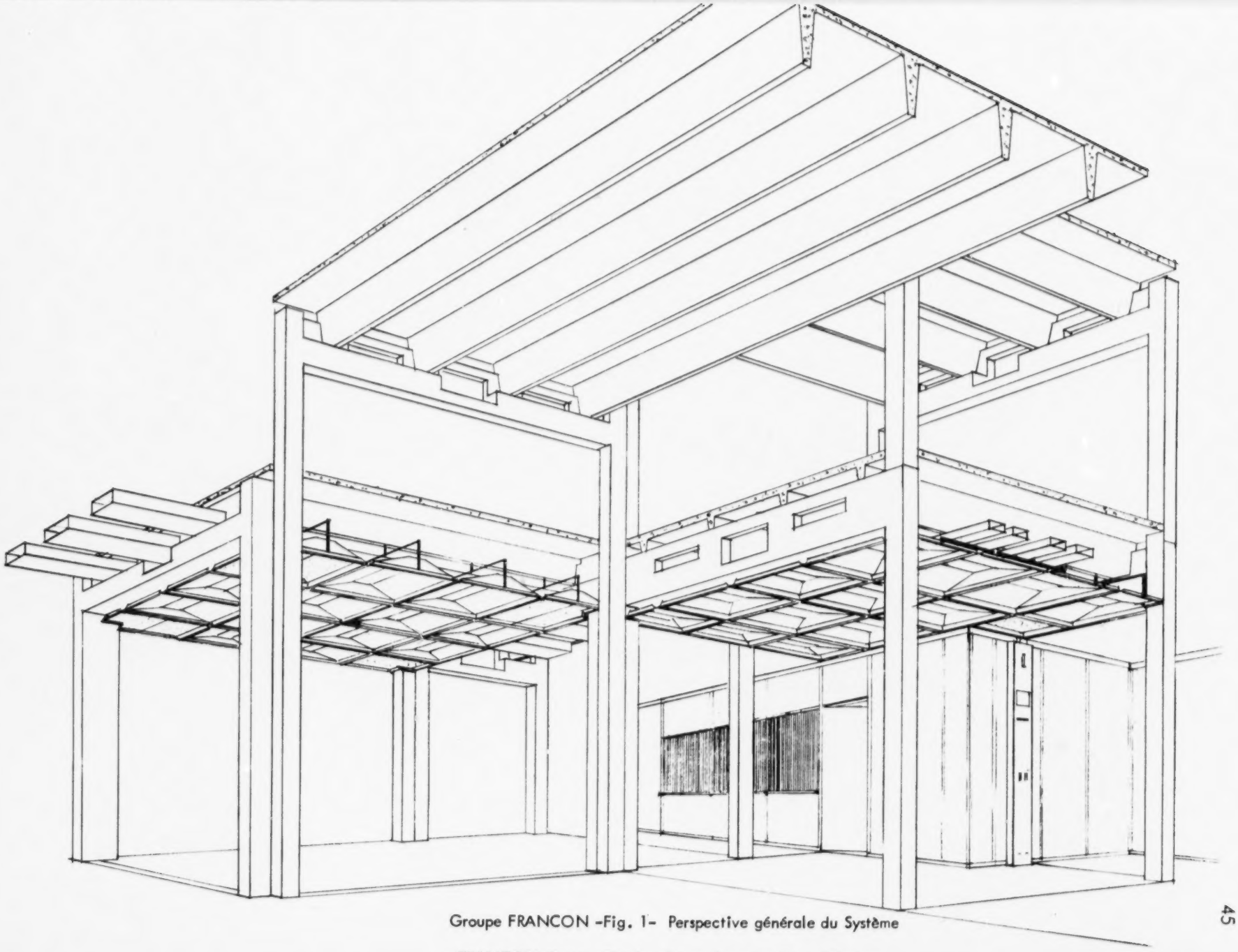
-the network of conduits with cables (distribution network supplying the primary and secondary nodes, control network, linking the primary nodes with the secondary nodes, lighting elements of the -PE Component and those not in System.

The voltage supplied must be 120/208 Volts, 60 cycle , 3 phase , 4 wire. The controls of the lighting fixtures of the -PE Component are 24 volts.

The installation grid of the primary and secondary nodes consists of a 20' 0" x 30' 0" grid, with the primary nodes installed in alternate rows. The installation grid of the secondary nodes consists of a 20' 0" x 20' 0" grid. The primary nodes are installed on the -ST Component portals, the secondary nodes on the slabs.

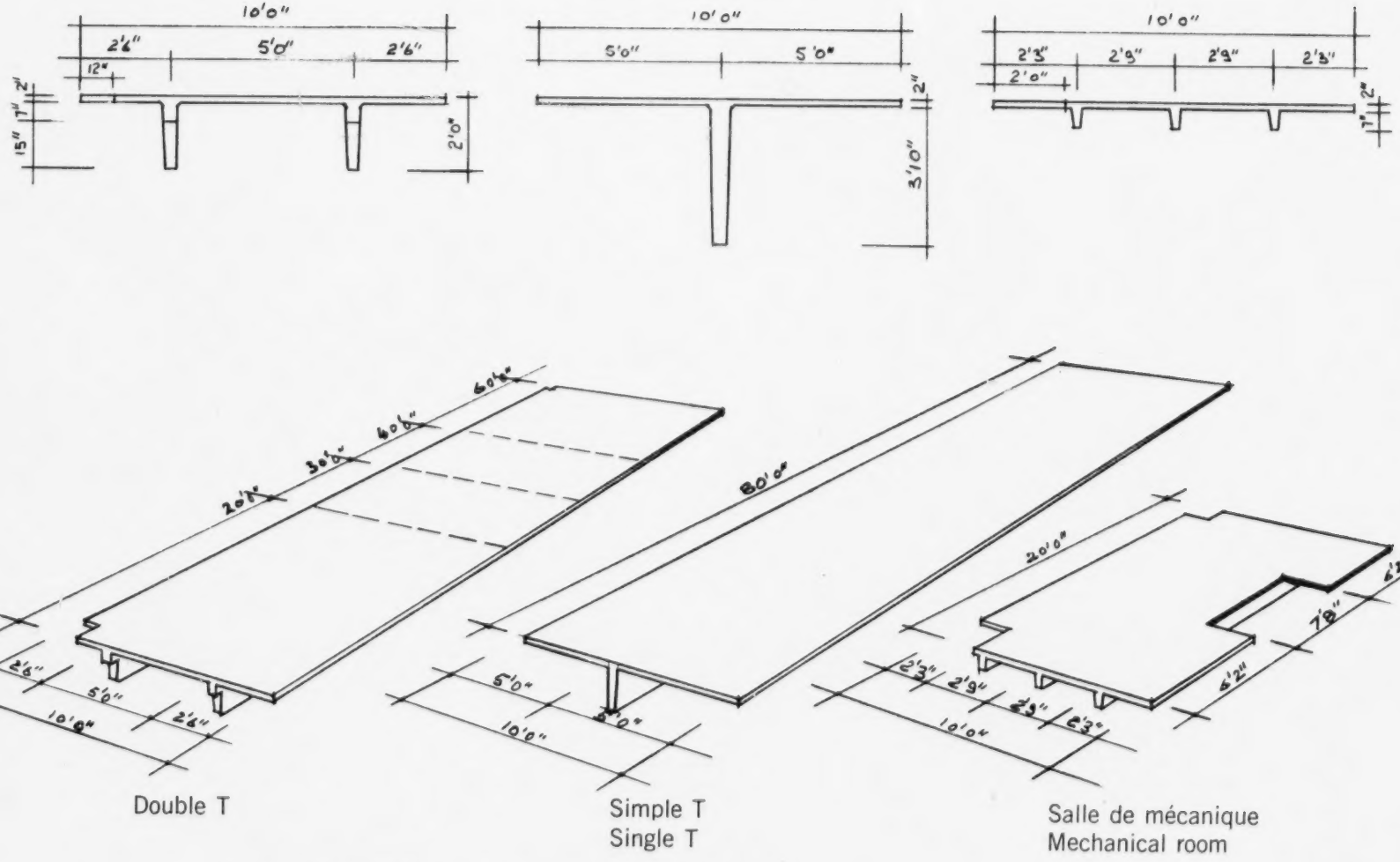
The displacement grid of the columnettes is the same as that of the -CL Component, 20" x 20", with possibilities of shifting 10".

The columnettes consist of a metallic rectangular prism (3 faces), 4" x 20" x 8' 10" high with the same finish as the partitions (manufactured by B.K. Johl) supporting equipment, connection boxes and conduits. The columnettes are backed up to and attached to a special panel of the -CL Component, through the top of which will pass the flexible cables to the connector boxes. Autonomous columnettes are achieved by assembling two columnette units back to back, and are connected to the rails of the -PE Component by a rectangular tube 1 3/8" x 5" x 20" bolted to the upper section; (same system of attachment as that of the partitions) this tube allows for passage of the flexible cables to the connector boxes.



Groupe FRANCON -Fig. 1- Perspective générale du Système

FRANCON Group -Fig.1- General perspective of System

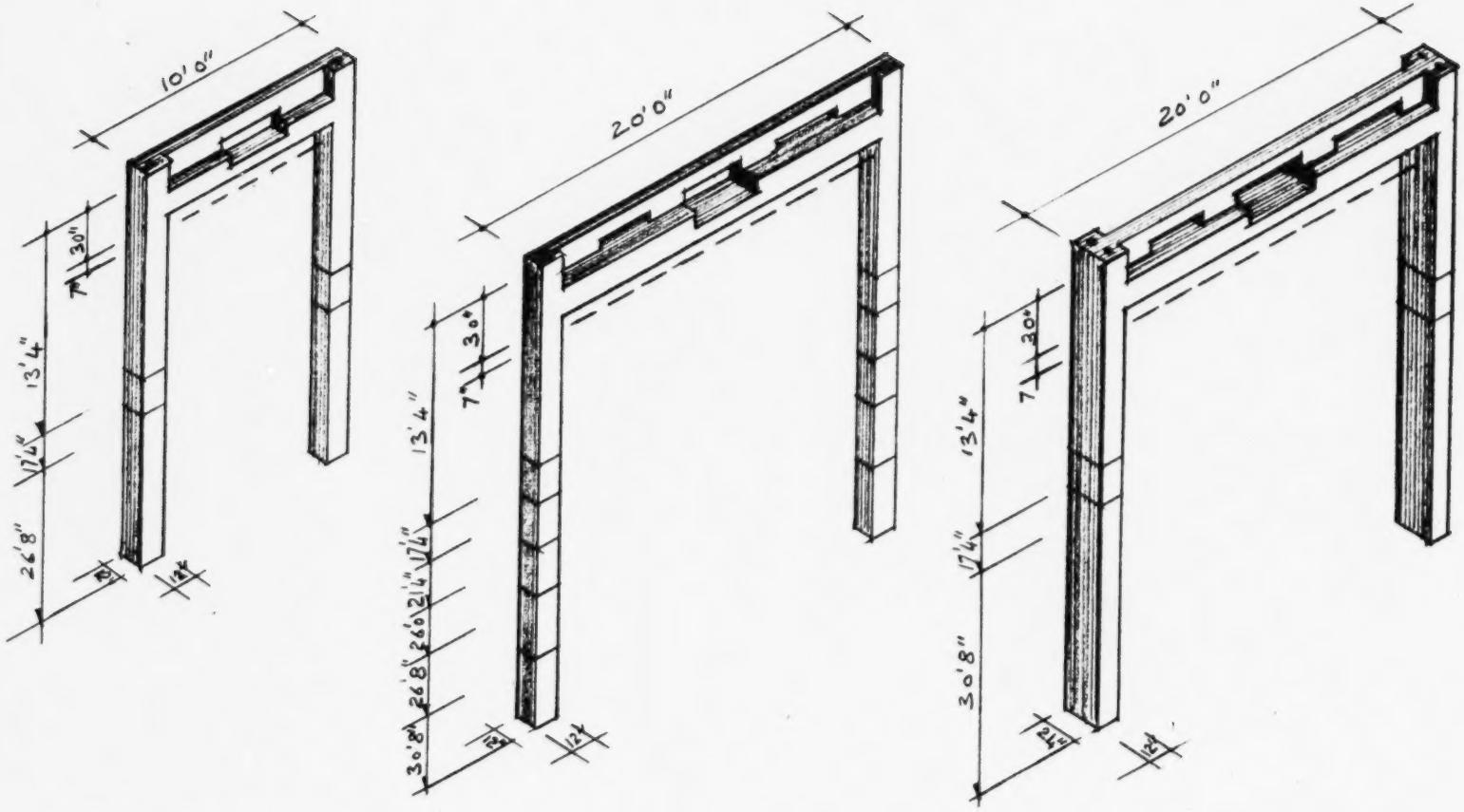



Double T

Simple T
Single T

Salle de mécanique
Mechanical room

Groupe FRANÇON - Fig. 2 - Composant -ST: Types de dalles
FRANCON Group - Fig. 2 - -ST Component: Types of slabs

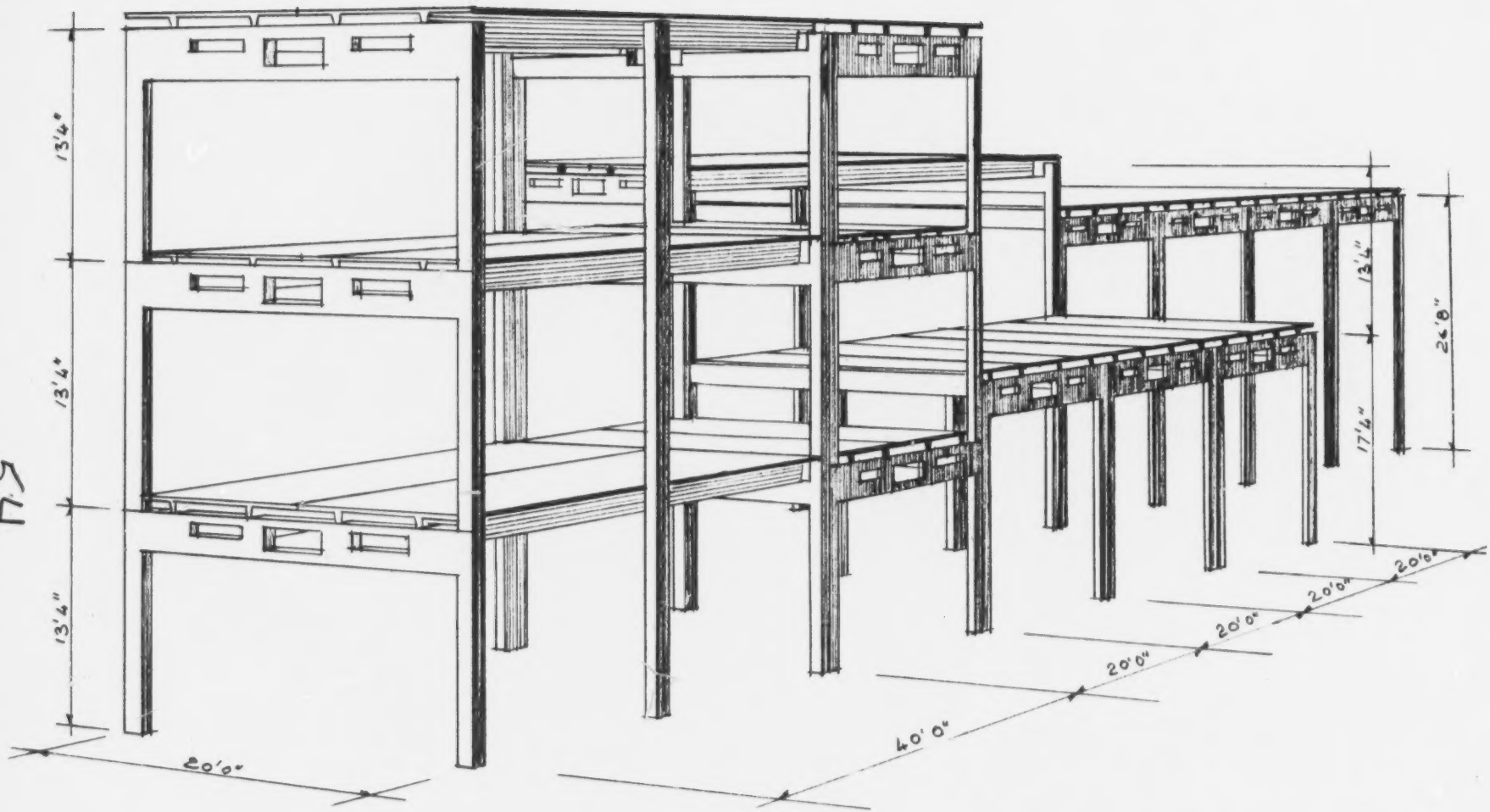



Simple 10'0"
Single 10'0"

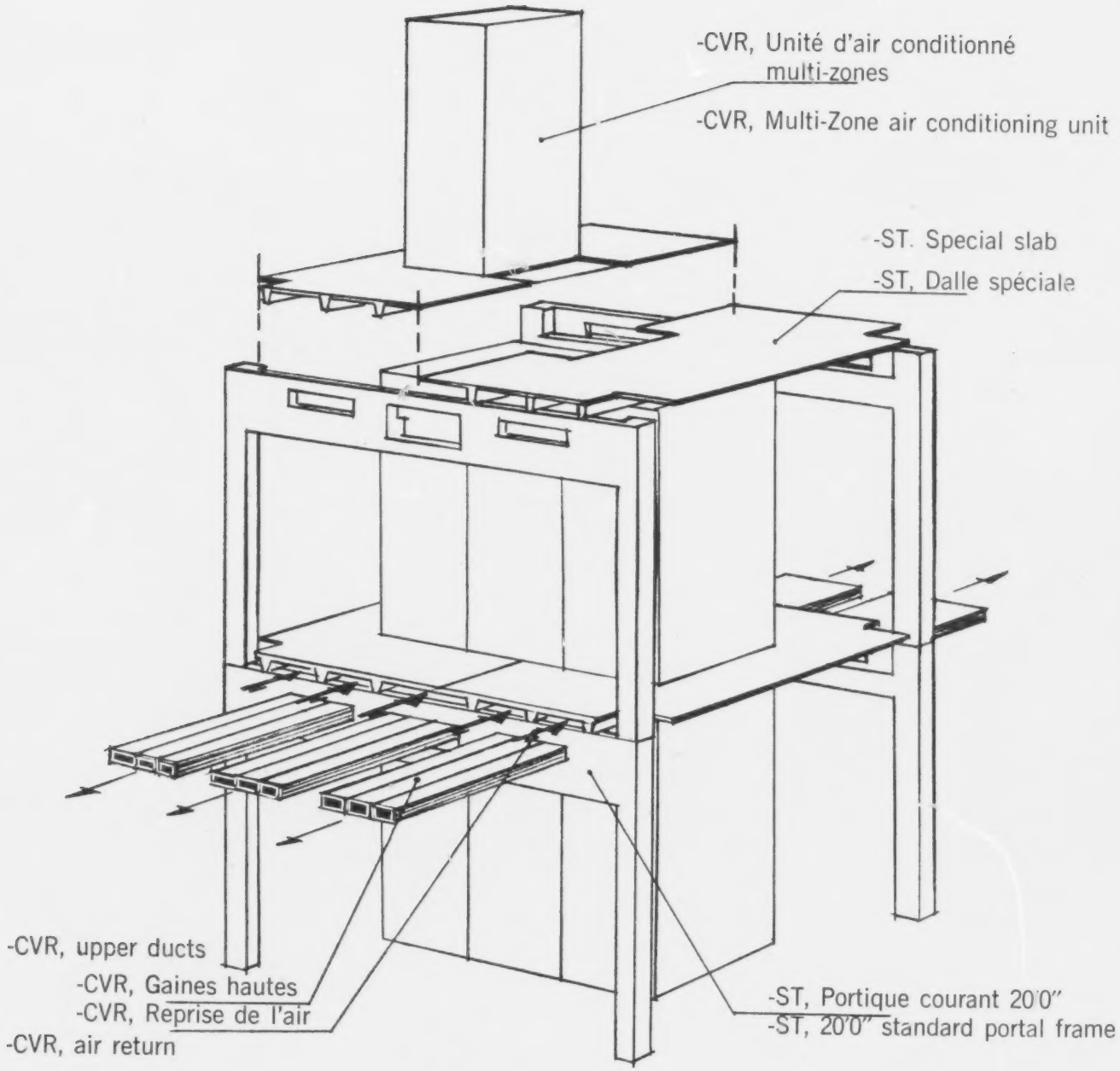
Simple 20'0"
Single 20'0"

Double 20'0"

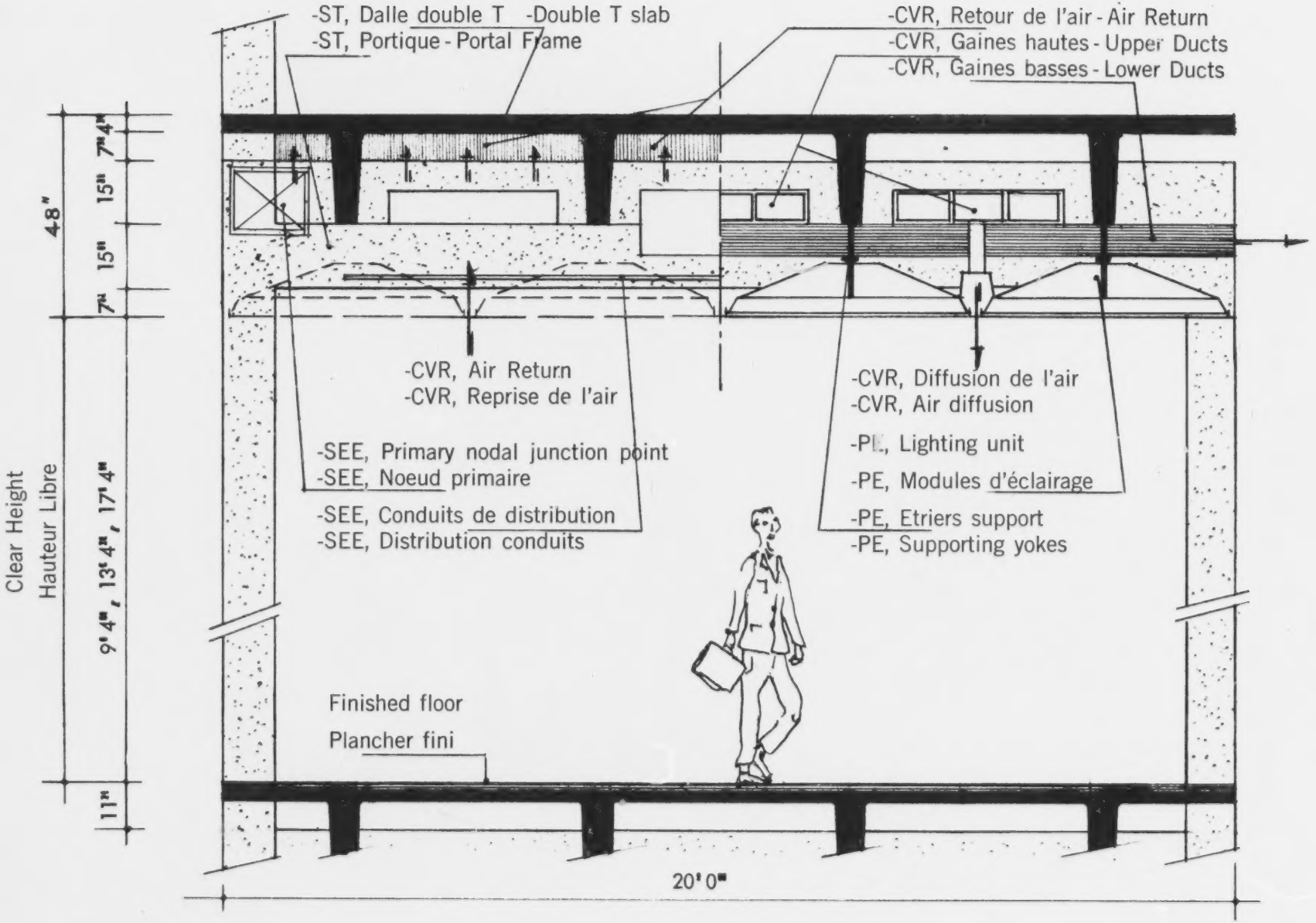
Groupe FRANCON - Fig. 3 - Composant -ST: Types de portiques
FRANCON Group - Fig. 3 - -ST Component: Types of portal frames



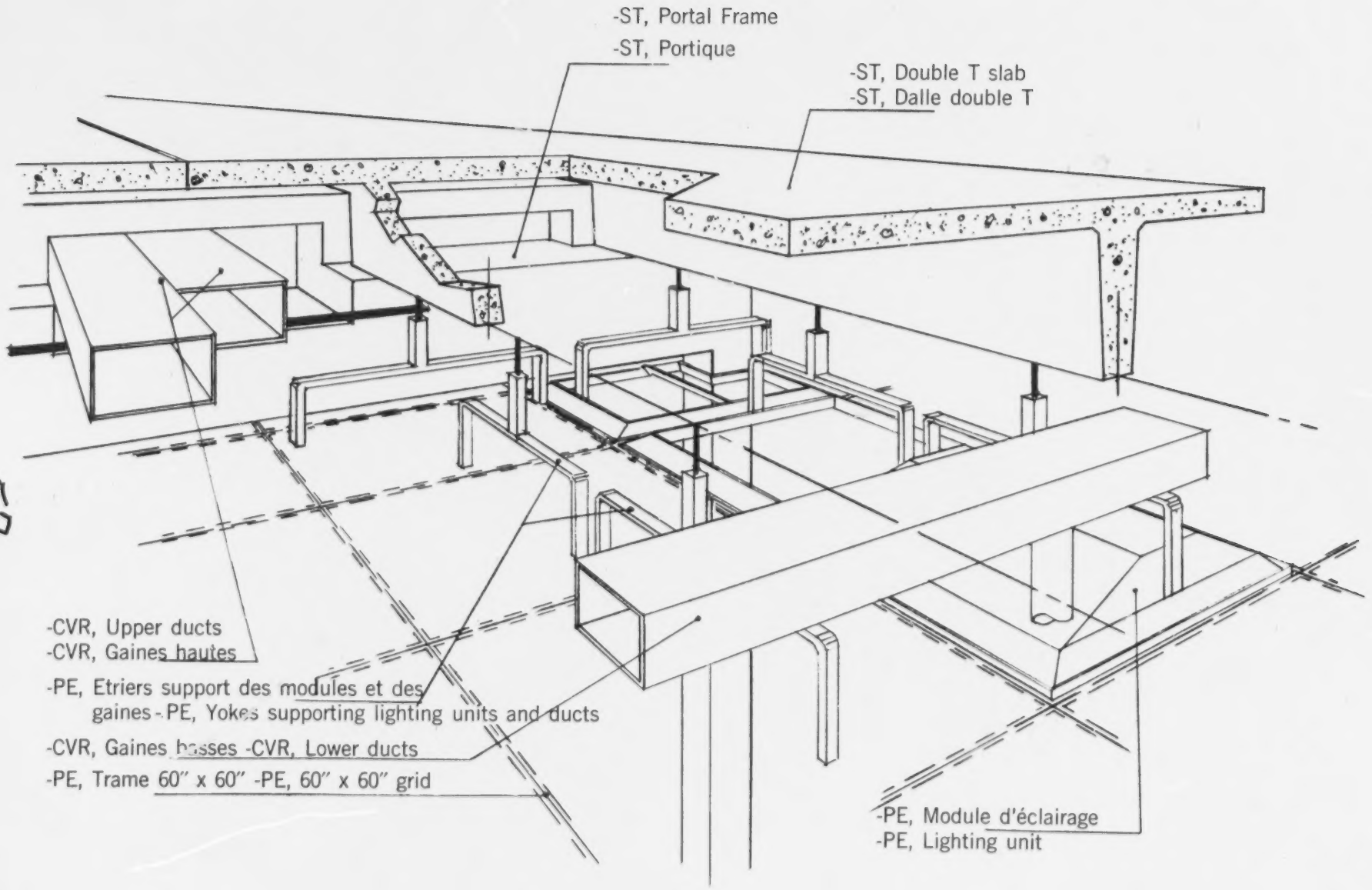

Groupe FRANCON - Fig. 4 - Composant -ST: Exemple d'assemblage des éléments
FRANCON Group - Fig. 4 - -ST Component: Typical assembly of elements



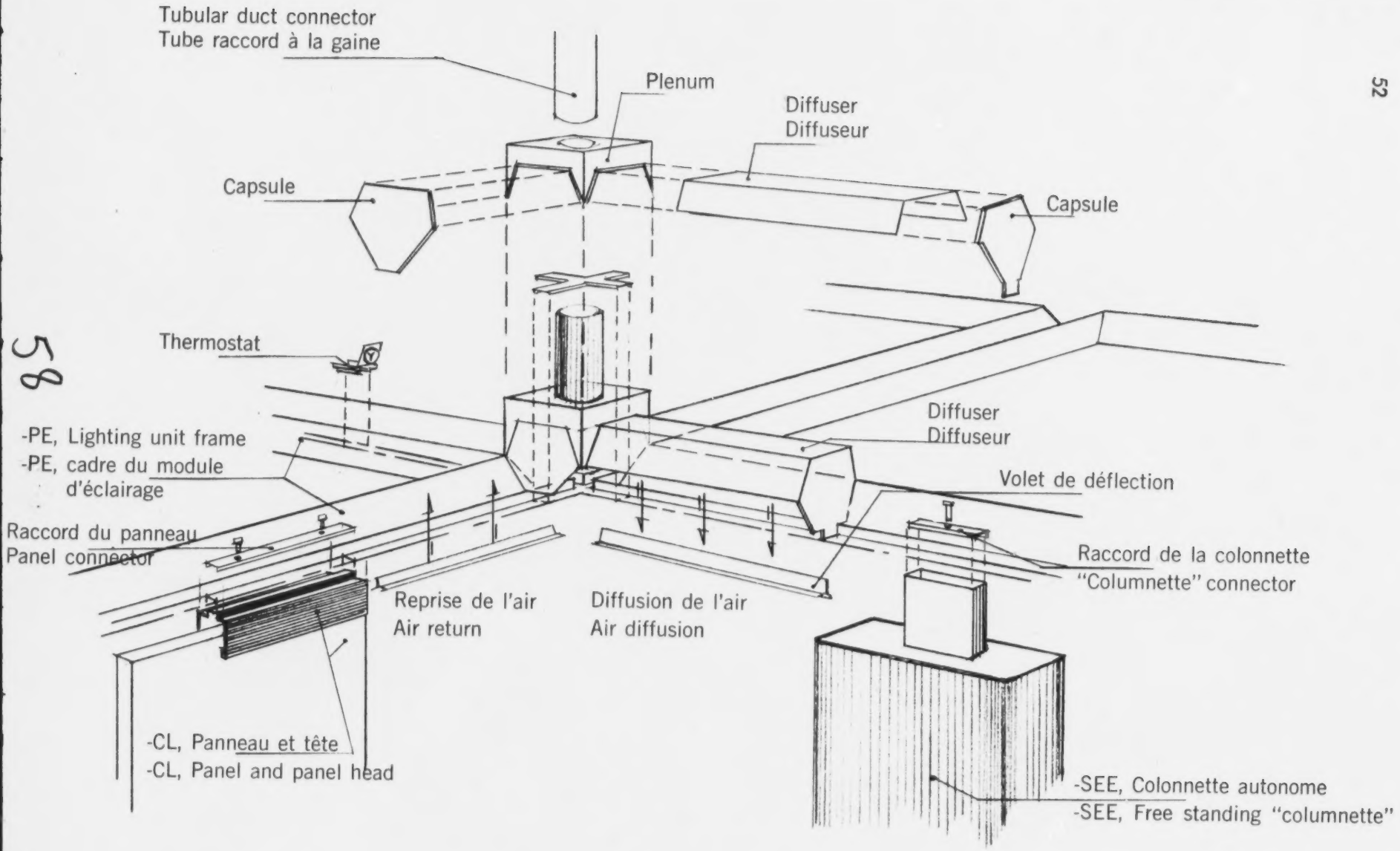

Groupe FRANCON - Fig. 5 - Composants -ST et -CVR:
Salles de mécanique, mise en place des éléments
FRANCON Group - Fig. 5 - -ST and -CVR Components:
Mechanical rooms – assembly of elements



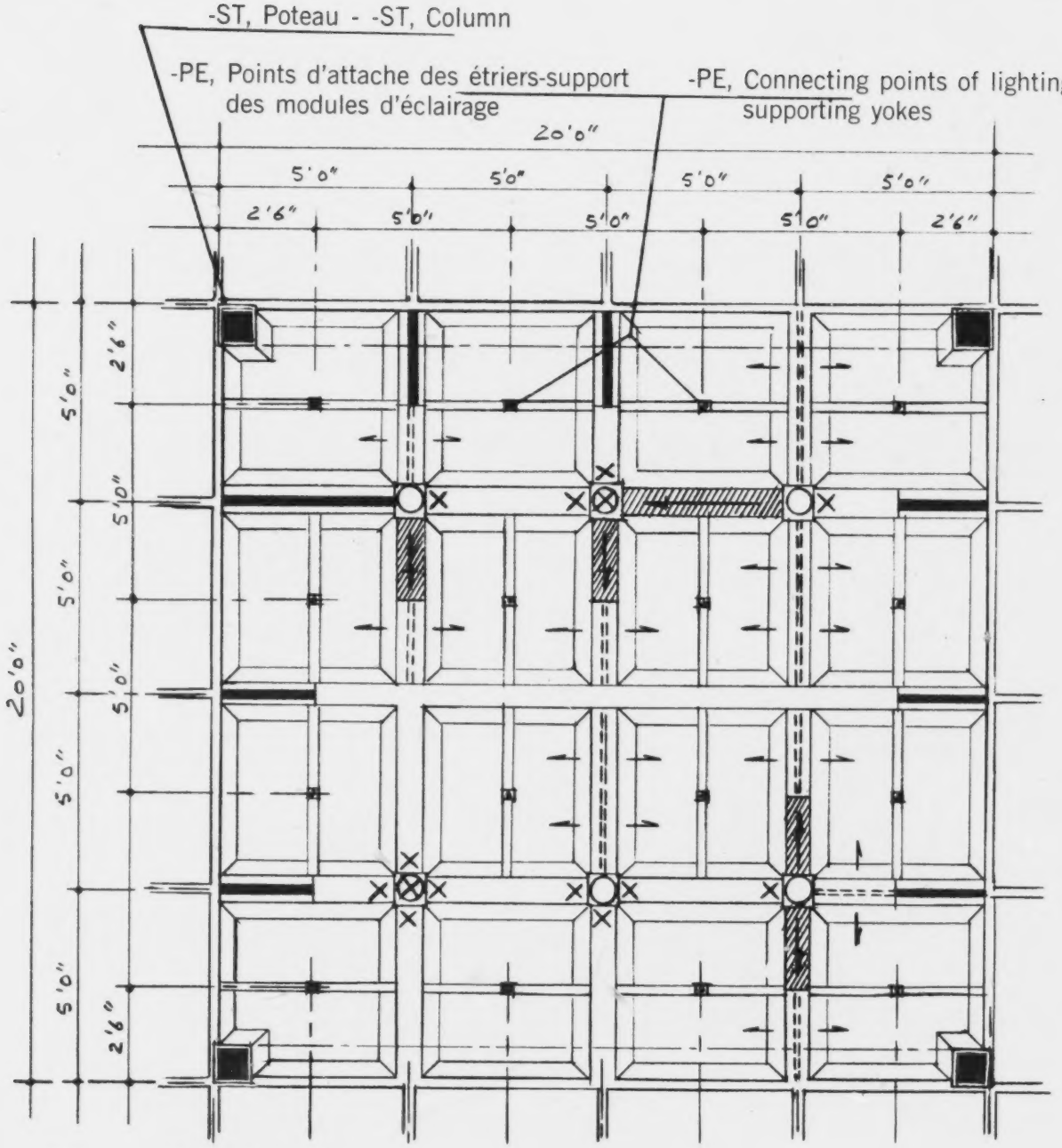

Groupe FRANCON - Fig. 6 - Esquisse d'intégration des Composants
FRANCON Group - Fig. 6 - Schematic illustration of Components integration


-ST, Portal Frame
-ST, Portique
-ST, Double T slab
-ST, Dalle double T
-CVR, Upper ducts
-CVR, Gaines hautes
-PE, Etriers support des modules et des gaines - PE, Yokes supporting lighting units and ducts
-CVR, Gaines basses -CVR, Lower ducts
-PE, Trame 60" x 60" -PE, 60" x 60" grid
-PE, Module d'éclairage
-PE, Lighting unit

Groupe FRANCON - Fig. 7 - Perspective d'intégration dans le sandwich
FRANCON Group - Fig. 7 - Illustration of the integration of components within the sandwich



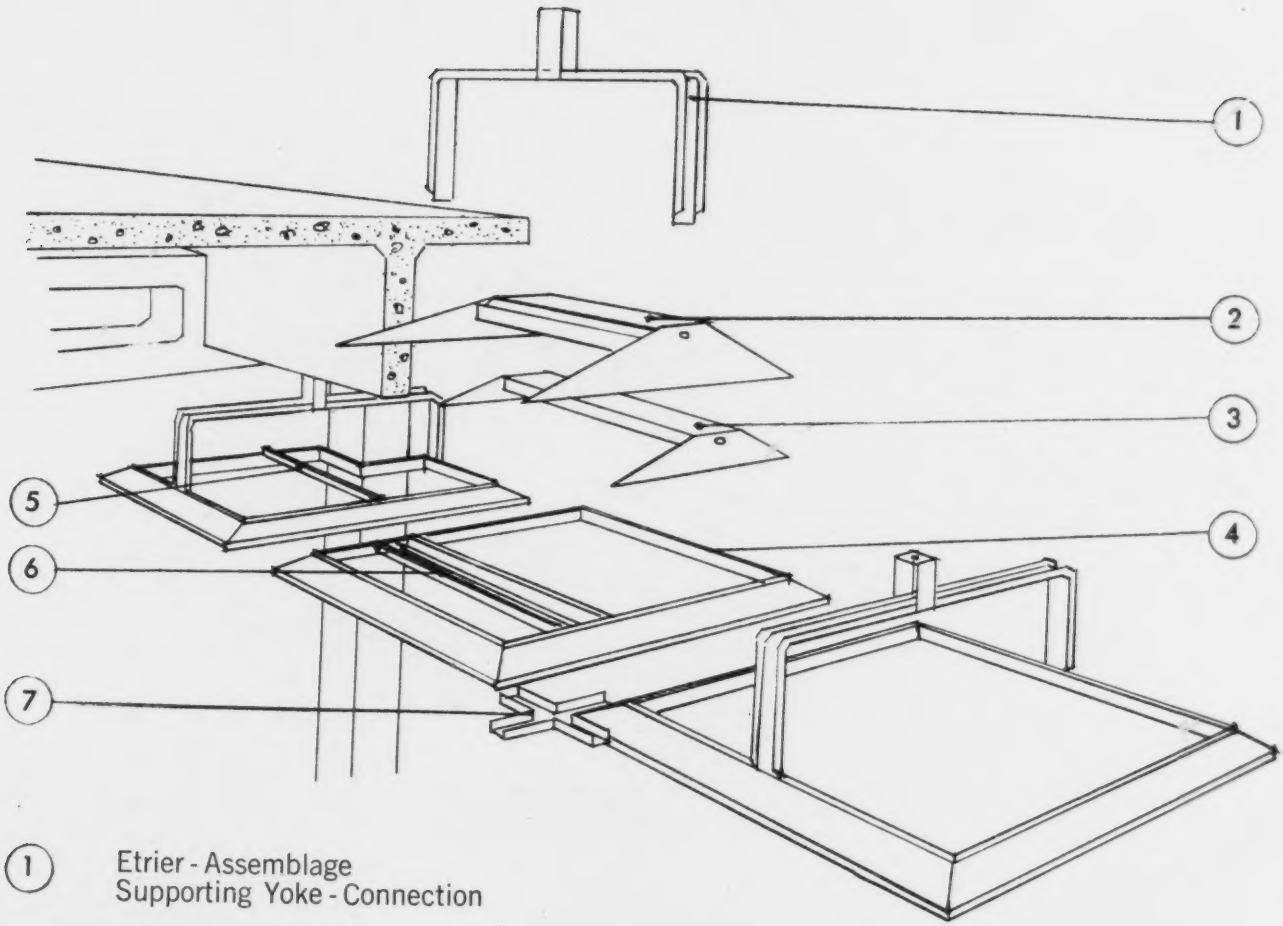

Groupe FRANCON - Fig. 8 - Perspective de mise en place des diffuseurs, cloisons et colonnettes dans le Plafond-Eclairage
FRANCON Group - Fig. 8 - Assembly drawing of air diffusers, partitions, and "columnettes" at the Lighting-Ceiling.




Groupe FRANCON - Fig. 9 - Composants -CVR et -PE:

Arrangement flexible de distribution de l'air sur plan des modules du plafond-éclairage - Trames.

FRANCON Group - Fig. 9 - -CVR and -PE Components: -Air distribution system - Plan of upper level of Lighting Ceiling - Grids




(1) Etrier - Assemblage
Supporting Yoke - Connection

(2) Appareil d'éclairage
Lighting Unit

(3) Bout - ⅔ Module
Tip - ⅔ Unit

(4) Côté du chassis STD
Side of STD Frame

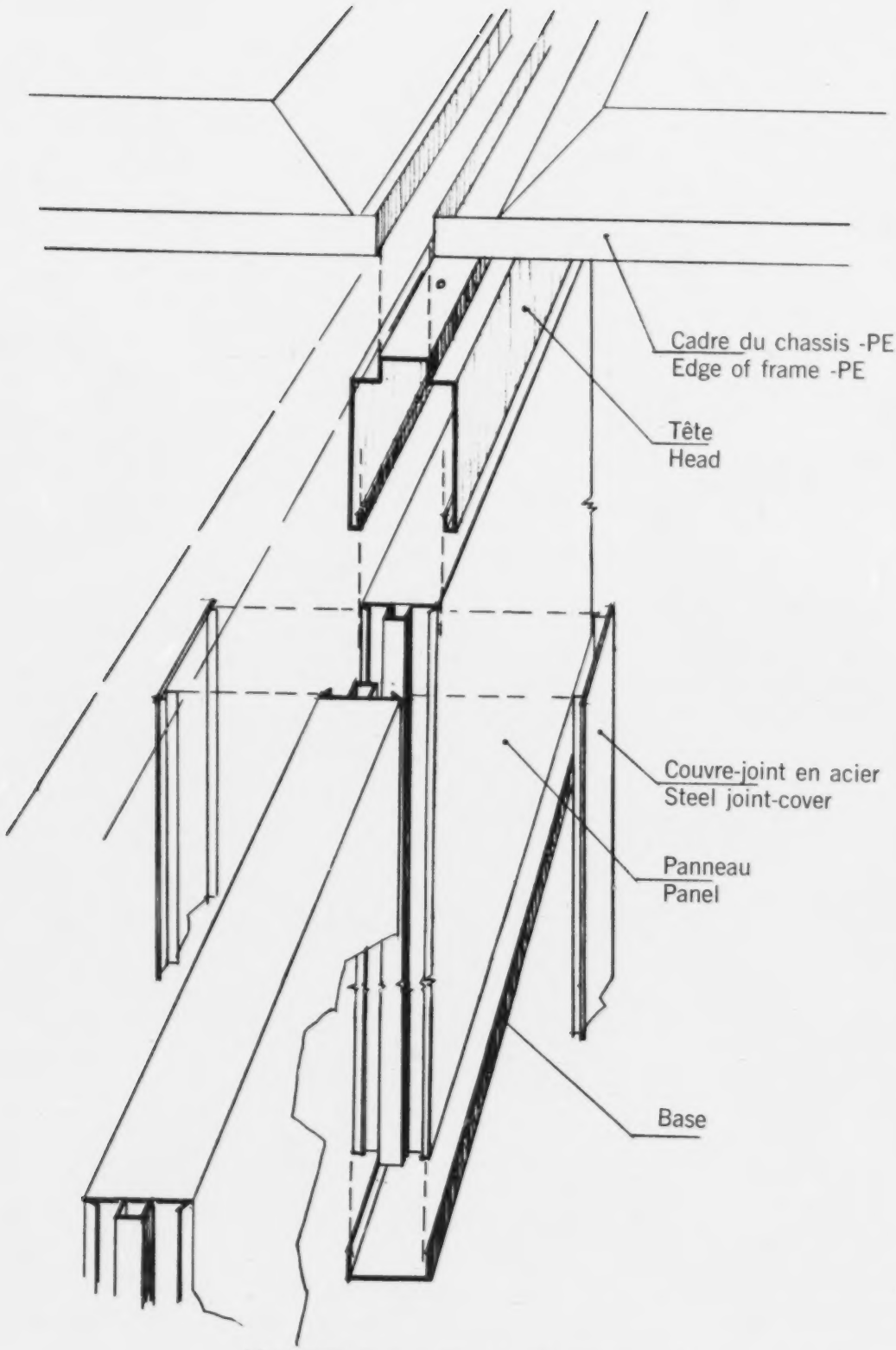
(5) Fer en "T"
Cross "T"

(6) Support Interm Assemblage
Interm Support Connection

(7) Joint Cruciforme Assemblage
Cruciform Connection Joint

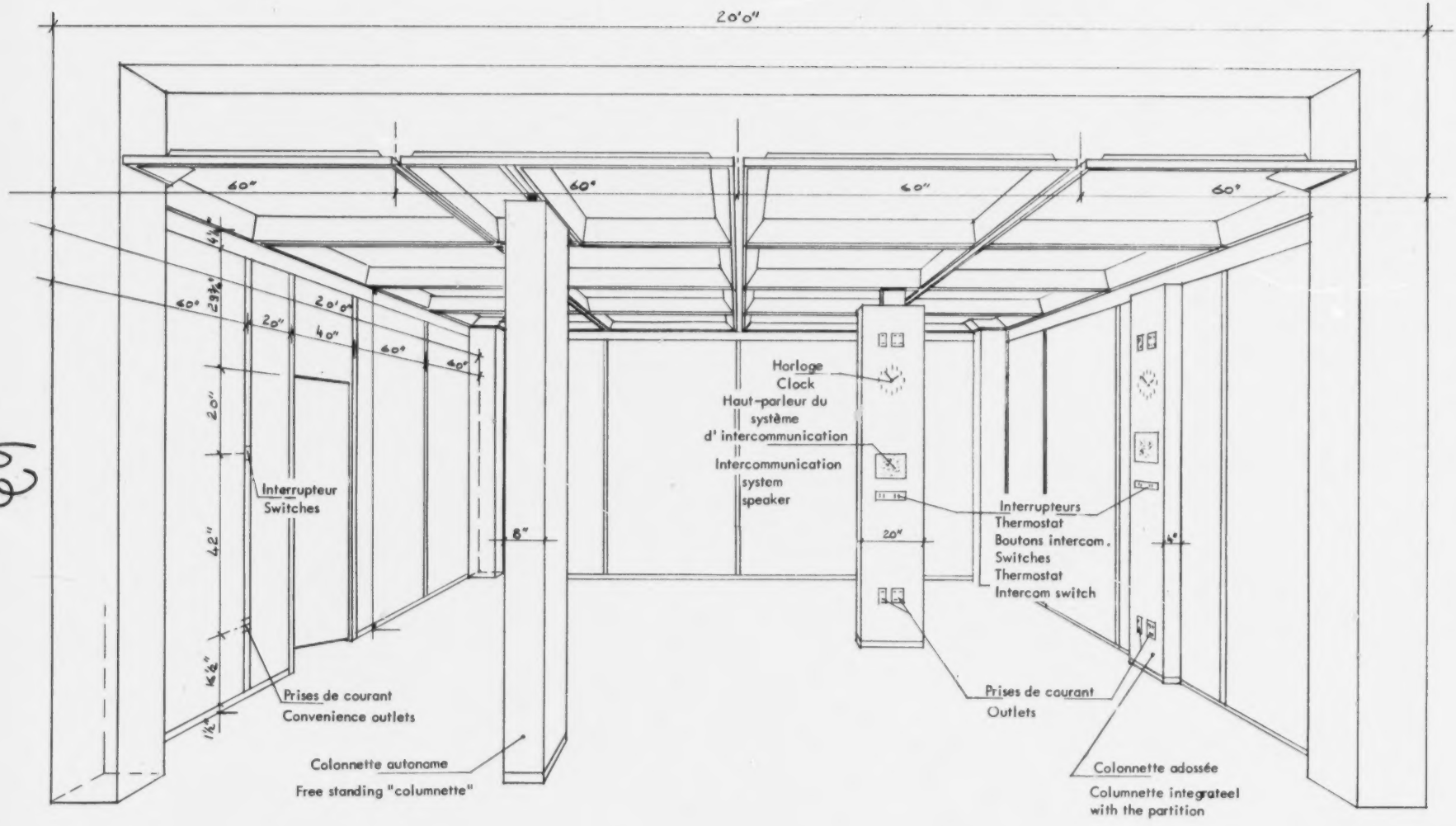
Groupe FRANCON - Fig. 10 - Composant PE
Perspective détaillée des modules

FRANCON Group - Fig. 10 - PE Component
Lighting Units Detailed Perspective




FRANCON Group - Fig. 11 - -CL Component:
Perspective drawing of partitions assembly

Groupe FRANCON - Fig. 11 - Composant -CL:
Perspective de montage des cloisons.




Groupe FRANCON -Fig. 12- Composant -SEE: Implantation des colonnettes.

FRANCON Group -Fig.12- SEE Component: Alternative "columnette" locations.

### 3.4.2 Dominion Bridge Group Systems

The Dominion Bridge Group Systems, three in number, are distinguished by the possible incorporation of three different bids for the CL-Component into the basic System; with the Bidders for the -ST, -CVR, -PE, and -SEE Components forming the basic system.

The three Systems consist of:

| | |
|---|---|
| Dominion Bridge Co. Limited | for the Structure Component |
| Dominion Bridge Co. Limited | for the Heating-Ventilation-Cooling Component |
| Canadian Johns Manville Co. Limited | for the Ceiling-Lighting Component |
| Atlas Asbestos Company (1) | for the Partition Component |
| B.K. Johl Inc. (2) | for the Partition Component |
| Canadian Johns Manville Co. Ltd (3) (Don Products Limited) | for the Partition Component |
| Dominion Bridge Co. Limited | for the Electric-Electronic Services Component |

Each of the three systems is based on a steel structure (with steel columns and also concrete columns), in which the use of joists allows for the passage of other Components.

The solution submitted offers a sandwich thickness of 56" in regular areas and 48" in gymnasia.

a) Structure Component (ST) - Dominion Bridge Co. Limited -

a) .1 General characteristics

Slab Types

The slabs of the floor elements are formed by a 3" concrete topping on steel decks of ribbed metal sheets. It should be noted that 3 inches of concrete on metal sheets are required to meet the requirements of fire protection.

Beam Types

- Primary beams

All girders consist of 16 inch rolled steel beams of varying capacities.

-Secondary beams

Secondary beams consist of three (3) types of joists:

a) 20" joists for spans of 10', 20' and 30'. These joists are spaced 30" apart.

b) 40" joists for spans of 40' and 60'. These joists are 60" apart.

c) 44" joists for spans of 80 feet (gymnasia). These joists are 60" apart.

- Peripheral beams

These are 16 and 30 inches rolled steel beams.

Types of columns

The Structure Component uses mainly two types of columns:

- Reinforced concrete columns with a steel capping for connection purposes.

- Tubular steel columns embedded in concrete for fire protection. The concrete is poured at the manufacturing plant.

a) .2 Particular characteristics of the -ST Component

The system proposed allows for a future enlargement of the school. Following the removal of the exterior wall, an extension of the building requires only minor repairs on site.

The integrotion of a steel framework and concrete columns allows for using the characteristics proper to the two materials: steel for tension and concrete for compression.

The use of columns, girders and joists of which dimensions have been normalized, has enabled the range of elements required to be decreased.

b) Heating-Ventilation-Cooling (CVR) Component
-Dominion Bridge Co. Limited

b) .1 General characteristics

Ventilation system distributing the air by means of a single high pressure duct, connected to a terminal reheat unit containing hot water coil.

The air is circulated at speeds varying from 2500 FPM for 3000 CFM to 6000 FPM for 43000 CFM and is maintained at a temperature of 58° F (dry bulb) (a minimum of 16 2/3% fresh air). Humidity is maintained according to the standards of the Performance Specifications.

Air is distributed to the rooms in the centre of the horizontal panels of the ceiling by means of rectangular diffusers.

The temperature required in the rooms is controlable by a thermostat installed on the door frames or columnettes. Each thermostat controls a 2-way pneumatic valve installed on the supply pipes of the heating box.

From the rooms air is returned along corridors through a return grill located in the door transoms; to the common return grill in the floor located near the mechanical room.

When the percentage of fresh air admitted increases, the surplus of air not recirculated is exhausted:

- for elementary schools by ventilators in the gymnasia roofs, by the exhaust fans of the washrooms, storeroom, shower rooms and cloakrooms. The rest of the air is exhausted through gravity louvres installed in the ceiling of the corridors of the storey and adjusted to +0.05" of water;

(Each exhaust fan can be set in operation by an electric pneumatic relay.)

-for Polyvalent Secondary schools by ventilation in the gymnasium roofs, by the exhaust fans in washrooms, store-rooms, shower rooms and cloakrooms, etc. The rest of the air is exhausted through various ventilation systems of the building such as those of kitchen, laboratories, workshops, etc. In these areas it is still necessary to install air intake systems to prevent the building from developing a negative pressure when the outside temperature is below or above 58°F.

b) .2 Particular characteristics

-Changes in dimensions of the spaces due to relocation of the partitions:

To meet these requirements, panels 30" x 60" including diffusers may be relocated and the amount of air in the boxes readjusted accordingly.

-Change in the thermal charge of an area:

The dimension of the coils in the boxes are calculated to take into consideration the necessary increase in the thermal change.

-Special requirements:

The proposed solution requires mechanical rooms on the roof, not more that 10' above the roof, as well as vertical ducts for air return.

c) Ceiling-Lighting Component (PE) -Canadian Johns Manville Co. Ltd

Note: At the last moment, no authorization was given to describe this solution.

d) Partition Component (CL) -Atlas Asbestos Company, Canadian Johns Manville Co. Limited, B.K. Johl Inc.-

The systems submitted by Dominion Bridge for the -ST, -CVR, -PE, -SEE Components are integrated with the three -CL Components mentioned above.

d) .1 Atlas Asbestos Solution - General characteristics

The -CL Component submitted by Atlas Asbestos consists of two filler panels attached to a steel structural system:

-each filler panel consists of two sheets of 1/8" Asbestos cement bonded to a 3/8" gypsum board,

-the outer face of the filler panel is painted; the inner face is stiffened to eliminate "gondolage",

-each filler panel may easily be removed separately from the partition system by first removing the pressure section covering the screws, and then the screws going through the steel retaining covers,

-lead sheets are used to reduce sound transmission through metal hardware; a rubber gasket is installed when it proves necessary,

-between the top of the partition head and the ceiling Fiberglass insulation is also used to reduce sound transmission and improve fire resistance rating,

-the door frames are sheet steel.

The standard width of a panel is 40". However 20" wide panels have been provided to meet installation requirements; 4" modular panels may also be supplied.

The partition surfaces are independant of one another, allowing for changes on one side without affecting those on the other side of the partition; among other things this enables necessary repairs to be made in case a panel is damaged.

The -CL Component also consists of:

-systems of fasteners allowing for attachment of tack boards, screens, geography maps as well as materials with acoustic surfaces,

-chalk boards,

-door frames which can be electrified where necessary.

d) .2 Canadian Johns Manville Solution (Don Products Ltd)

General characteristics

The -CL Component proposed by Johns Manville consists of parts assembled in a rigid structure with narrow joints, with no bolt or rivet visible.

-the partition walls, 3" in total thickness are formed of two 1/2" gypsum boards covered by a 24-gauge steel plate with an interior space of 2"; the vertical sides of the panels are of rolled steel to interlock mechanically and be aligned with the studs, standard panels are assembled so as to produce a partition with narrow joints every 30 inches from center to center; when the partitions lengths are not multiples of 30" units, special widths are used to adapt to the 20" module;

-the studs go from floor to ceiling and are fitted to the expansion cap by means of extensions attached to the studs; they are formed of two cold-rolled steel members; these studs provide for a positive mechanical interlock with the panels and are spaced 30" from one centre to another;

-base, 4 inches high, is made of cold-rolled steel, painted and covered by clear vinyl to make it scratch proof; assembly of the base allows for adjustment of up to 2 inches for relocation purposes;

-the expansion cap, of cold-rolled steel slides between opposite panels and allows for a 2" adjustment in height; it is also equipped with a sound and light proof device.

Finishes

A single type of finish is used in all the areas and is applied on a zinc surface which is chemically treated to ensure good adhesion to the paint and resistance to corrosion. The surface is then covered by a vinyl base paint and baked at a high temperature, then a protective coat of transparent vinyl is applied.

The system submitted is perfectly integrated with the 5' grid of the ceiling. This system moreover includes the door frame as well as scantling, 2-1/2" wide by 3 inches deep, adjoining the door frame, to accommodate all the electrical equipment required.

d) .3 B.K. Johl Solution - General characteristics

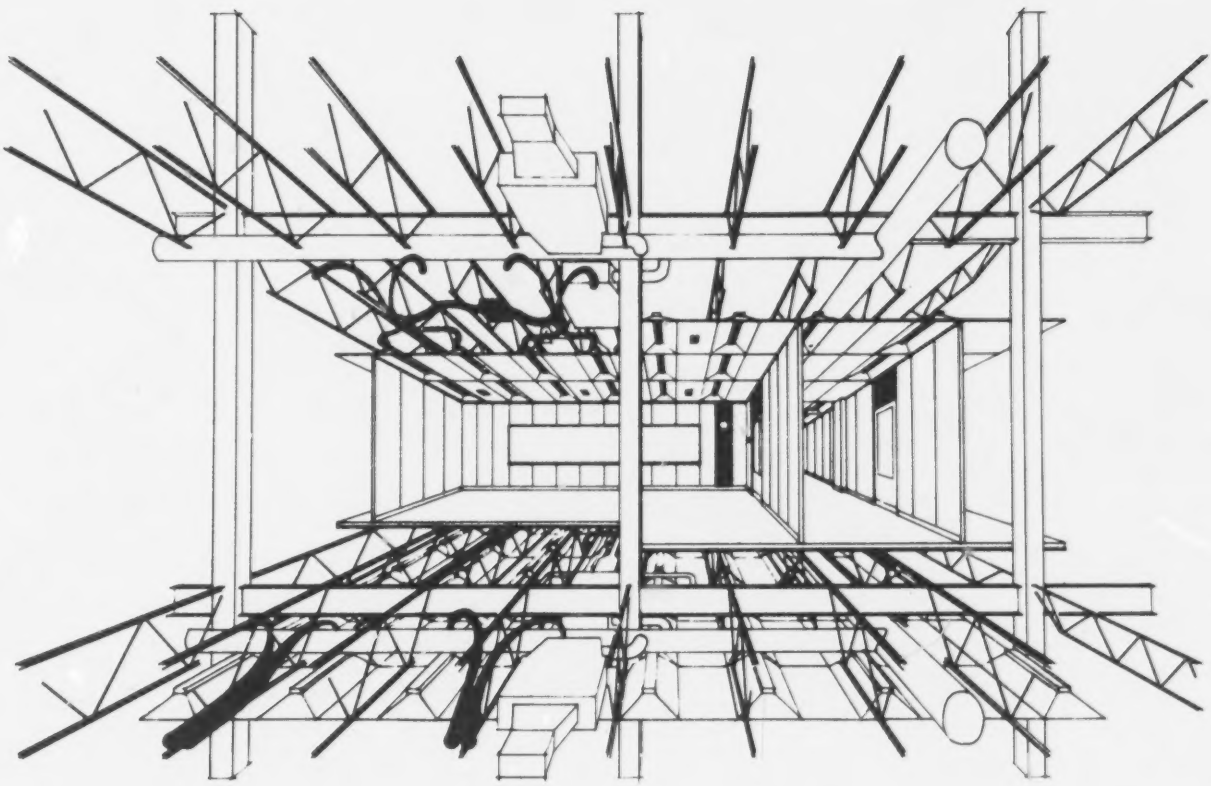
This solution is similar to that proposed by B.K. Johl in integrating with the Francon System (See presentation of the Francon Group, Partition Component).

e) Electric-Electronic Services Component (SEE) - Dominion Bridge Co. Ltd

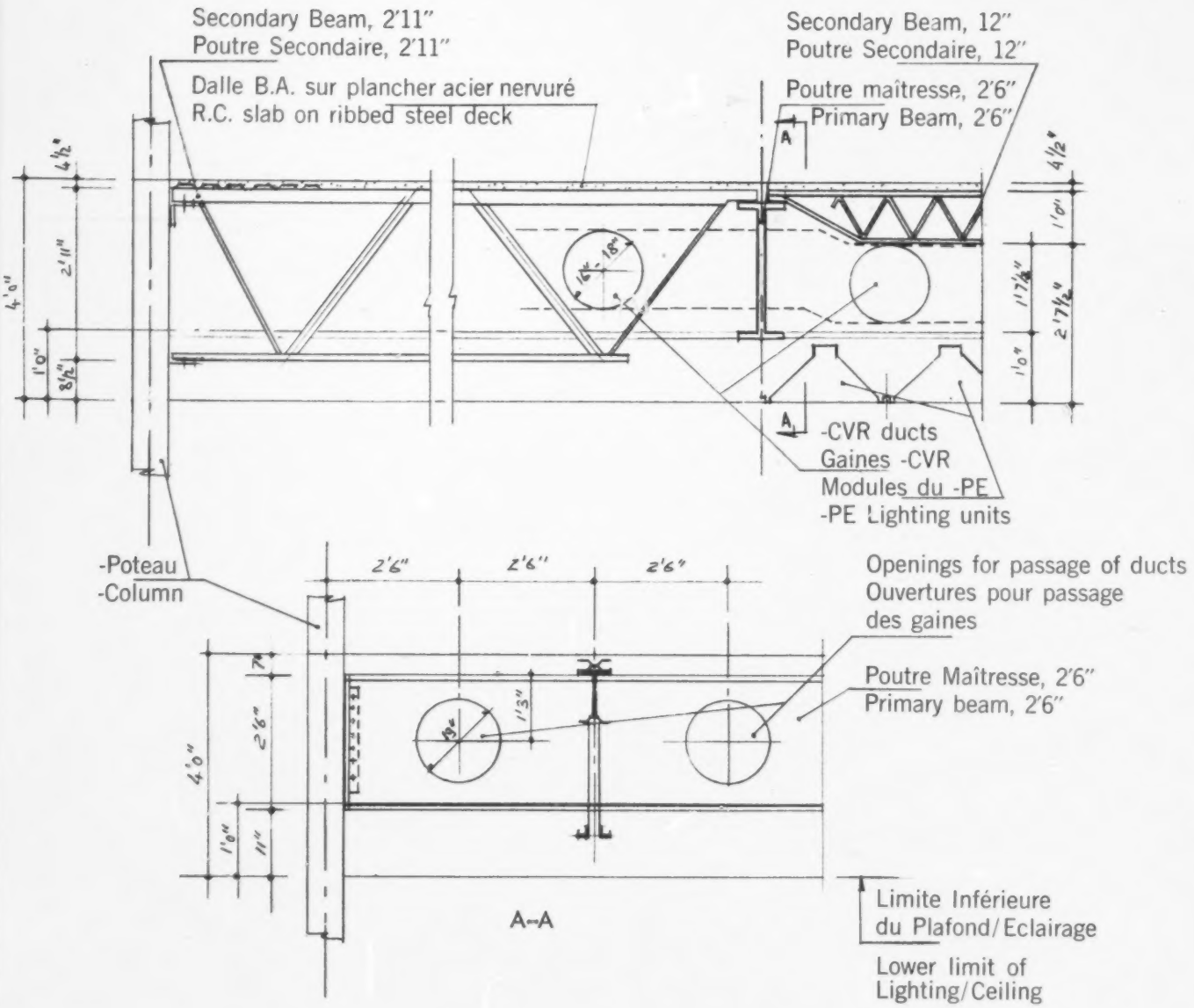
General characteristics

The -SEE Component consists of:

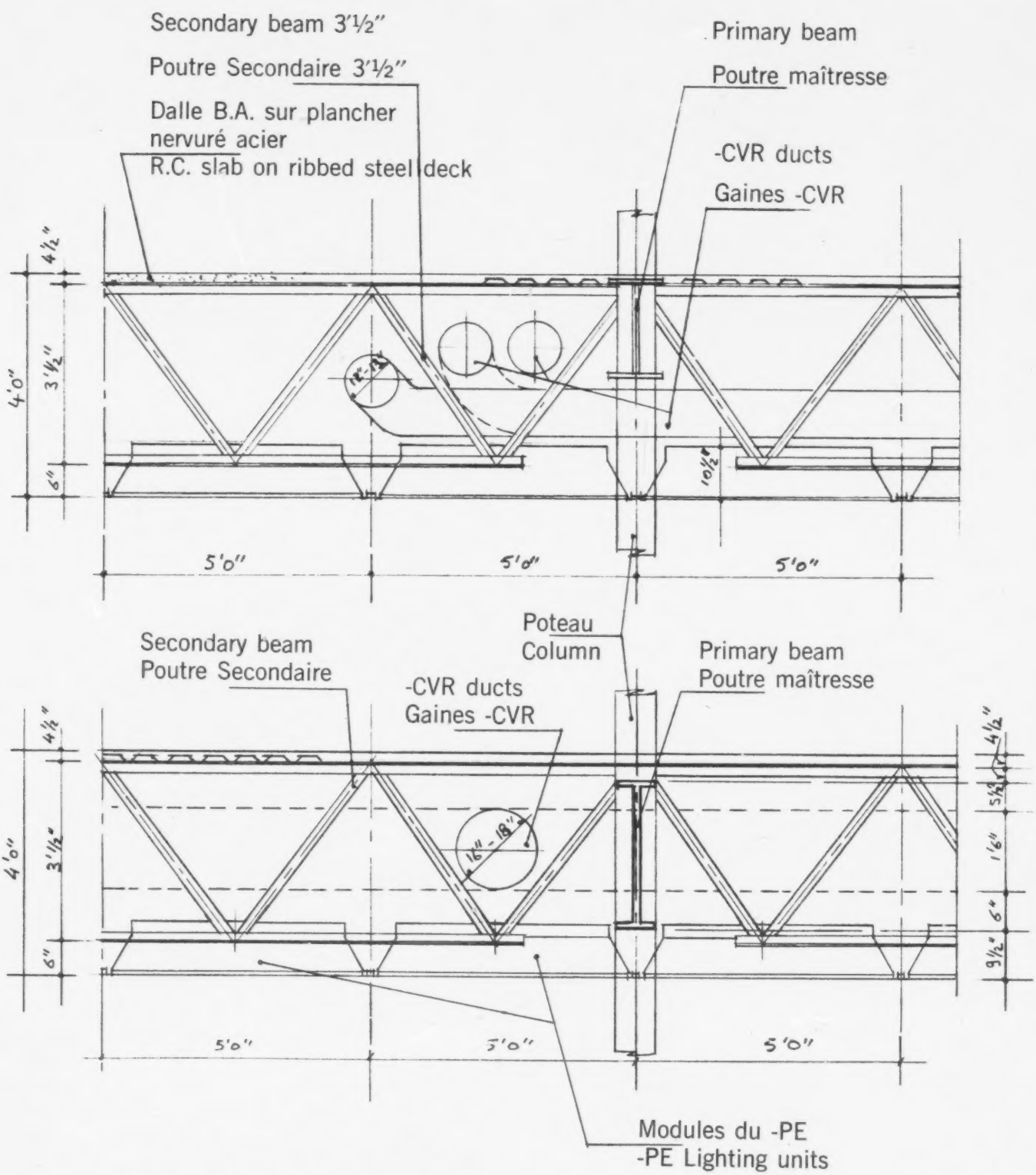
-primary nodes; each of these nodes serving an area of 1200 square feet (30' x 40'); each primary node consists of two distinct terminal boxes; one for the 120 V (high voltage) current, and the other for low voltage;



Groupe DOMINION BRIDGE - Fig. 1 - Perspective générale du Système
DOMINION BRIDGE Group - Fig. 1 - General perspective of system




Groupe DOMINION BRIDGE - Fig. 2 - Coupes sur le sandwich
DOMINION BRIDGE Group - Fig. 2 - Sections through the sandwich

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Groupe DOMINION BRIDGE - Fig. 3 - Coupes sur le sandwich
DOMINION BRIDGE Group - Fig. 3 - Sections through the sandwich

-secondary nodes, each of these nodes serving a surface of 400 square feet (20' x 20'); the voltage is 347 V, with two secondary nodes per circuit;

-columnettes (2 types) which can accommodate the equipment stipulated;

-wiring for lighting fixtures for PE-1, PE-2 and PE-3 type ceilings;

-wiring in electrified door frames.

### 3.4.3 Canron Group Systems

The Canron group Systems, three in number, are distinguished by the possible incorporation in the basic system of three different Bids for the -CL Component, with the -ST, -CVR, -PE and -SEE Components forming the basic System.

The three Systems consist of:

| | |
|---|---|
| Canron Limited | for the Structure Component |
| Canron Limited (Lennox Industries Canada Limited) | for the Heating-Ventilation-Cooling Component |
| Canadian Johns Manville Co. Ltd | for the Ceiling-Lighting Component |
| Canadian Johns Manville Co. Ltd (1) | for the Partition Component |
| B.K. Johl Inc. (2) | for the Partition Component |
| Atlas Asbestos Company (3) | for the Partition Component |
| Namur Equipement | for the Electric-Electronic Services Component |

Each of these three Systems is based on a steel structure sufficiently open to allow for passage of ventilation ducts of the -CVR Component and thus leave it to the four Components -CVR, -PE, -CL and -SEE to provide proper integration, relating to the -PE Component module.

The solution offers a sandwich thickness of 48" in the regular rooms and 56" in the gymnasia.

a) Structure Component (ST) - Canron Limited

a) .1 General characteristics

-steel columns, beams and decking
-concrete topping on decking.

Type of slab

Minimum of 3" thick 3000 lb concrete on ribbed steel decking.

Decking

The decking is made of U shaped steel ribs between the secondary beams in order to hold the membranes in alignment and aid in distributing concentrated stresses.

Type of beams

-Primary beams

All the girders are H rolled steel beams or welded plate girders, generally with a depth of 18".

-Secondary beams

-18" deep beams for spans up to 20'

-34" deep beams for spans of 30' to 60'

-50" deep beams for spans of 80'

In every case, the beams will be spaced 5' from centre to centre.

Type of columns

Four sizes of square tubular type columns are provided: 6", 7", 8" and 10" with a factory welded base; they are equipped with a cap plate. All the columns receive a fire proof covering with a hard polished coating. The exterior finished size of the columns is generally 12" x 12" when square tubular columns 10" x 10" are used, the exterior finished size is then 16" x 16".

a) .2 Specific characteristics

Fire protection

Columns are fireproofed to ceiling height: the ceiling system provides fire protection complying with Montreal standards.

b) Heating-Ventilation-Cooling Component (CVR) - Canron/Lennox

General characteristics

The proposed solution uses one or more low speed systems: one or more "Multi-Zone" type units supply the various zones to be served. This system is substantially the same as that proposed by Lennox for the Francon solution.

Differences between the Francon and Canron -CVR solution

With the Canron system:

-Peripheral mechanical rooms are used;
-A linear diffuser system is used;
-Diffusers are connected to the main supply shafts by flexible ducts.

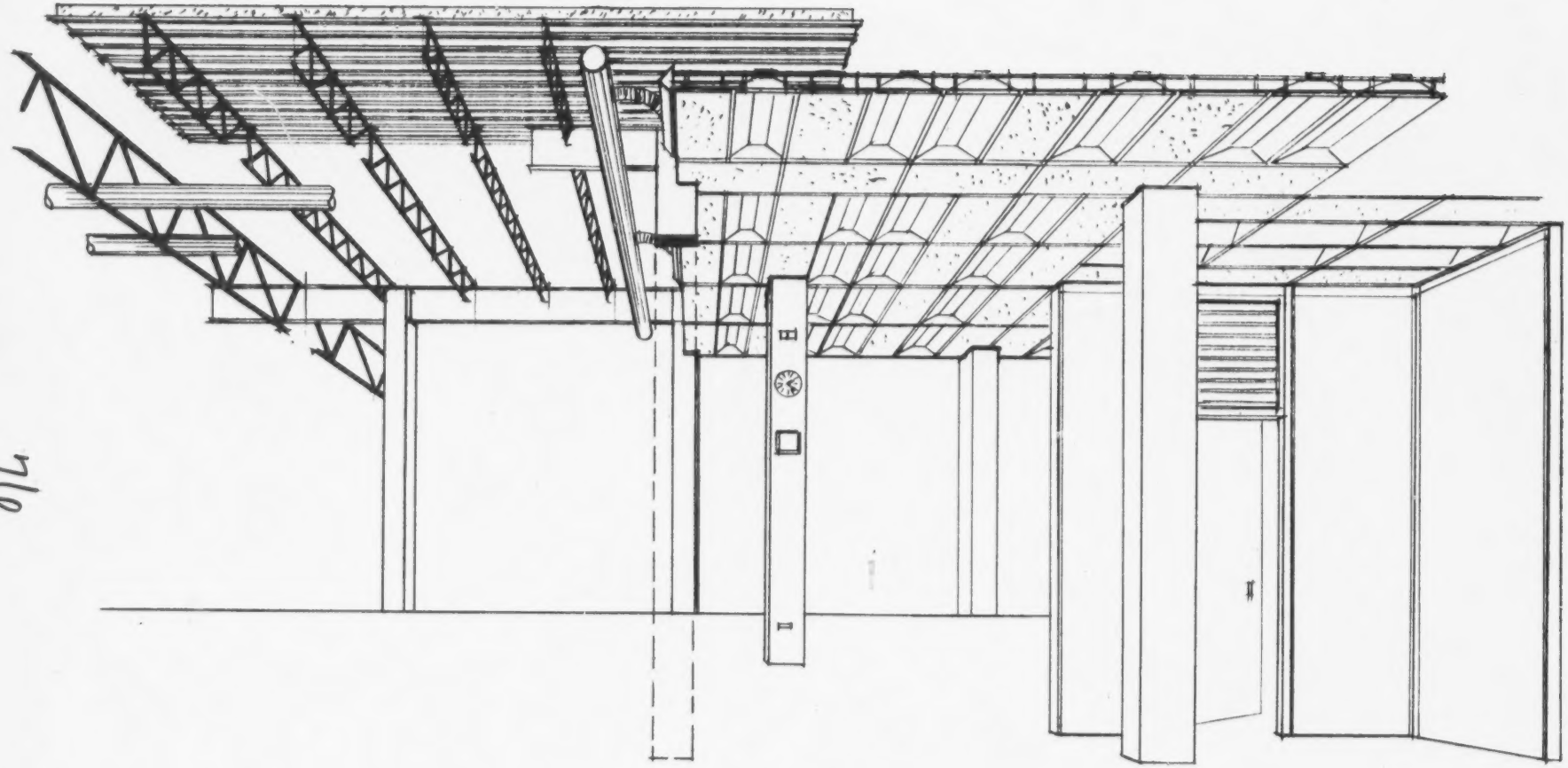
c) Ceiling-Lighting Component (-PE) - Canadian Johns Manville Co. Ltd

Note: At the last moment, no authorization was given to describe this solution.

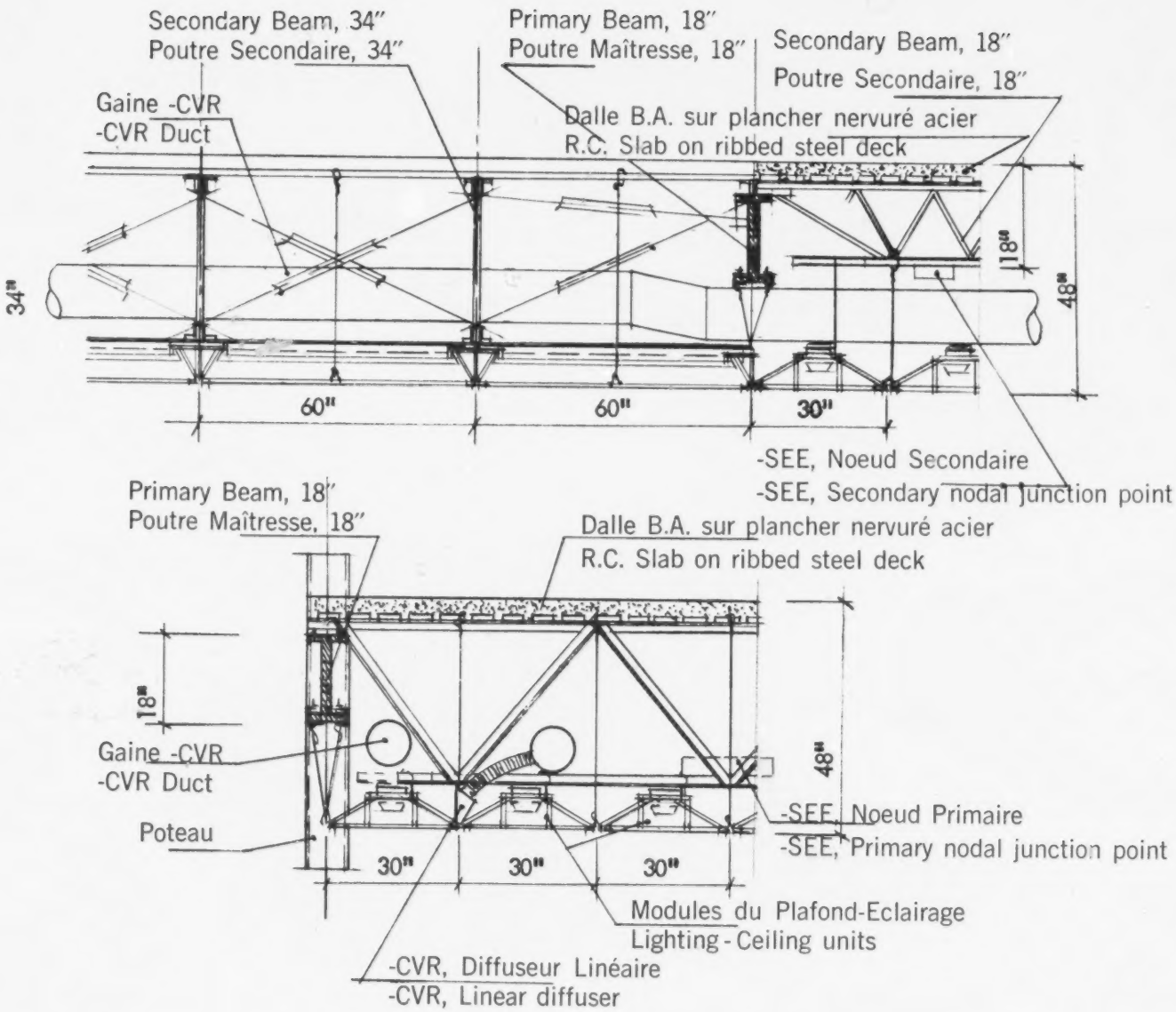
d) Partition Component (CL)

The basic system submitted by Canron for the -ST, -CVR, -PE and -SEE Components integrates with the three -CL Components as follows:

Canadian Johns Manville Co. Ltd - See Dominion Bridge Presentation
Atlas Asbestos Company - See Dominion Bridge Presentation
B.K. Johl Inc. - See Francon presentation



Groupe CANRON - Fig. 1 - Perspective générale du Système
CANRON Group - Fig. 1 - General perspective of System




Groupe CANRON - Fig. 2 - Coupes sur le Sandwich montrant l'intégration des éléments

CANRON Group - Fig. 2 - Sections through Sandwich illustrating the integration of components

e) Electric-Electronic Services Component (SEE) - Namur Equipement

General characteristics

Supply network: free of cables, consists of conduits attached to the structure, from electric panels to the nearest primary node in the zone to be served by each of the electric panels.

Distribution network: also consists of conduits attached to the structure connecting a group of secondary nodes to a primary node.

Nodal junction points: the method of wiring in conduits requires switch boxes; these are provided for on an installation grid and also constitute nodal junction points.

Columnette: a columnette is connected to a primary node by a flexible cable with a metallic sheath 30" long. The columnette itself is part of the -CL Component bid.

Electrified door frame: the electrified door frame is connected to a primary node by flexible cables, with a metallic sheath 40" long so as not to limit the flexibility of partition aiignment.

3.4.4 Janin Construction Limited Group Systems

The Janin group Systems, three in number, are distinguished by the possible incorporation in a basic System of three different bids for the -CL Component, with the -ST, -CVR, -PE and -SEE Components forming the basic system.

The three systems consist of:

| | |
|---|---|
| Janin Construction Limited | for the Structure Component |
| American Air Filter of Canada | for the Heating-Ventilation-Cooling Component |
| Canadian Johns Manville Co. Ltd | for the Ceiling-Lighting Component |

| | |
|---|---|
| Canadian Johns Manville Co. Ltd (1) | for the Partition Component |
| Atlas Asbestos Company (2) | for the Partition Component |
| B.K. Johl Inc. (3) | for the Partition Component |
| Namur Equipement Limitée | for the Electric-Electronic Services Component |

The System is based on a reinforced concrete system poured on site; this structure is designed so as to reduce overcrowding to a minimum thus allowing for passage of the -CVR Component ducts (Maximum depth "beams plus slab": 30 5/8" and no beams for 20'-0" spans). The four Components -CVR, -PE, -CL and -SEE are integrated, relating to the -PE Component module.

Thus the solution proposed a sandwich which is not very thick: 40" in regular areas, 52" in gymnasia.

a) Structure Component (ST) - Janin Construction Limited

a) .1 General characteristics

Reinforced concrete poured on site with the exception of structural steel elements with an 80' span for the gymnasia. This structure includes composite type beams and columns; it is continuous.

Types of slabs

The solution proposed consists of 2 types of slabs: reinforced concrete for 20', 30', 40' and 60' spans and structural steel for 80' spans (gymnasia roof).

The reinforced concrete slabs are thin slabs installed between 20'-0" x 20'-0" grid lines with a 12'-0" x 12'-0" central part recessed from the lower horizontal plane; thickness of the 12'-0" x 12'-0" recess: 5" to 6"; thickness of the perimeter strip: 9-1/2" to 10-1/2".

For 20'-0" spans this strip forms a "slab and beam" combination resting directly on the columns without an intermediary beam; for 30'-0", 40'-0" and 60'-0" spans, it serves as a compression table for the main beams (defined as secondary beams in the Performance Specifications) in a longitudinal direction; for the same spans it serves as a rib in the transverse direction and transmits loads to main beams.

Types of beams

With the exception of 80' spans, the structure includes two types of beams: reinforced concrete beams and composite concrete and standard "I" beams. They are 30-5/8" deep.

Openings have been provided in these beams for passage of ventilation ducts.

Types of columns

Composite columns are generally used with composite beams, so as to make erection easier. They are also used as supports in the case of 80' spans. All the others columns are made of reinforced concrete. Regular dimensions are 16" x 16" and 20" x 20".

a) .2 Special characteristics

-no main beams in the transverse span direction;
-use of prefabricated mobile framework;
-great simplicity in the structural system;
-possibility of changing direction.

b) Heating-Ventilation-Cooling Component (CVR) - American Air Filter of Canada Limited and Canadian Comstock Co. Ltd

General characteristics

The proposed solution uses one or more low speed system, one or more "Multi-Zone" type units supply various zones to be served, of which the temperature is controlled by pneumatic

regulators. Air is returned through the corridors by using return grilles in transoms over the doors. As a rule, the units are installed at floor level to be served; therefore, no units (or mechanical rooms) are to be installed at roof level.

Circulation in shafts takes place without encumbrance parallel to the 30', 40' and 60' beams. In the transverse span direction openings 13-1/2" in diameter, spaced 5' centre to centre are provided in the beams to allow various services to go through. The bulk of the sandwich is illustrated by these two figures.

c) Ceiling-Lighting Component (PE) - Canadian Johns Manville Co. Ltd

Note: At the last moment, no authorization was given to describe this solution.

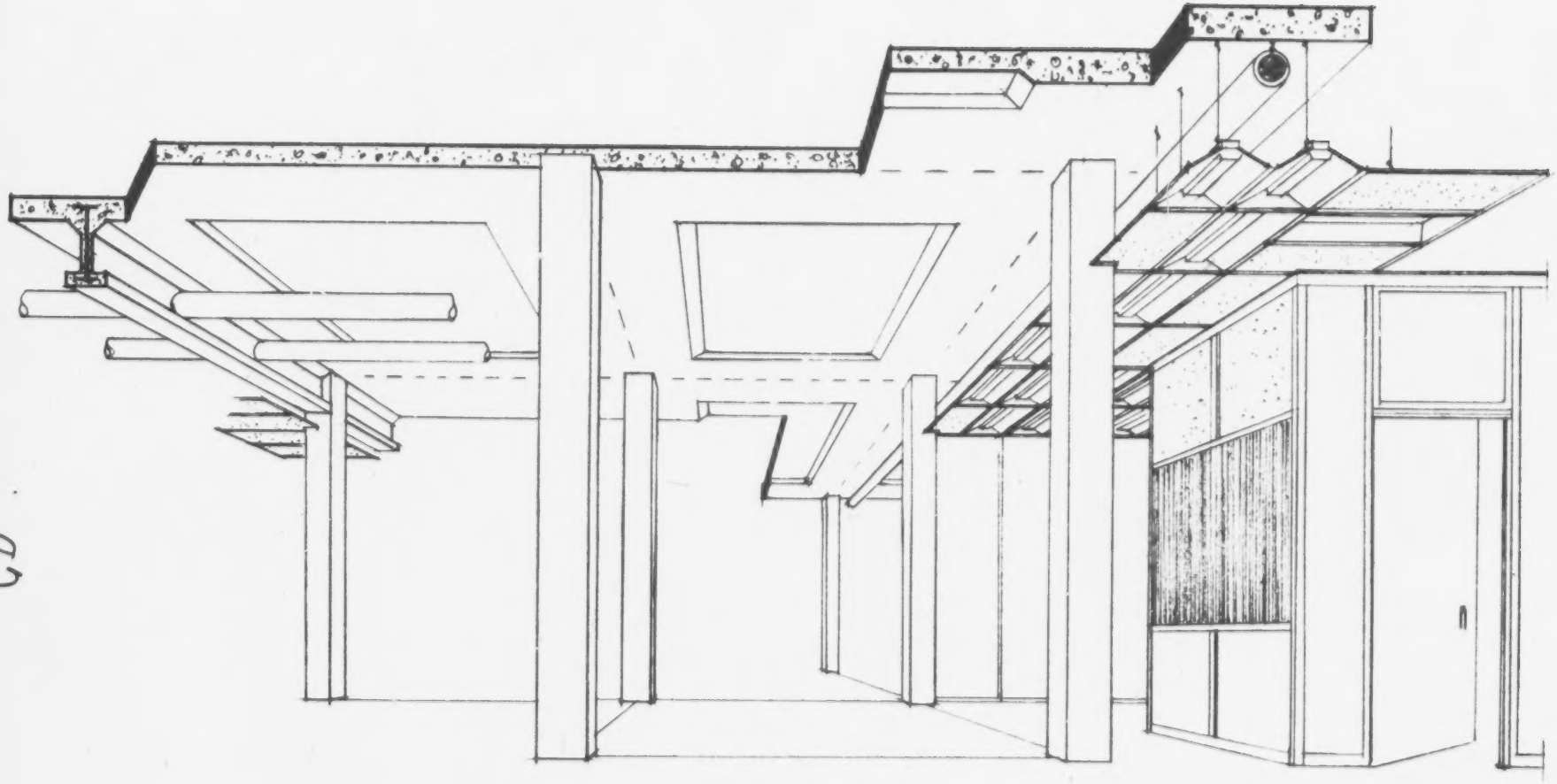
d) Partition Component (CL)

The systems proposed by Janin Construction Limited for the -ST, -CVR, -PE and -SEE Components are integrated with the three -CL Component bidders as follows:

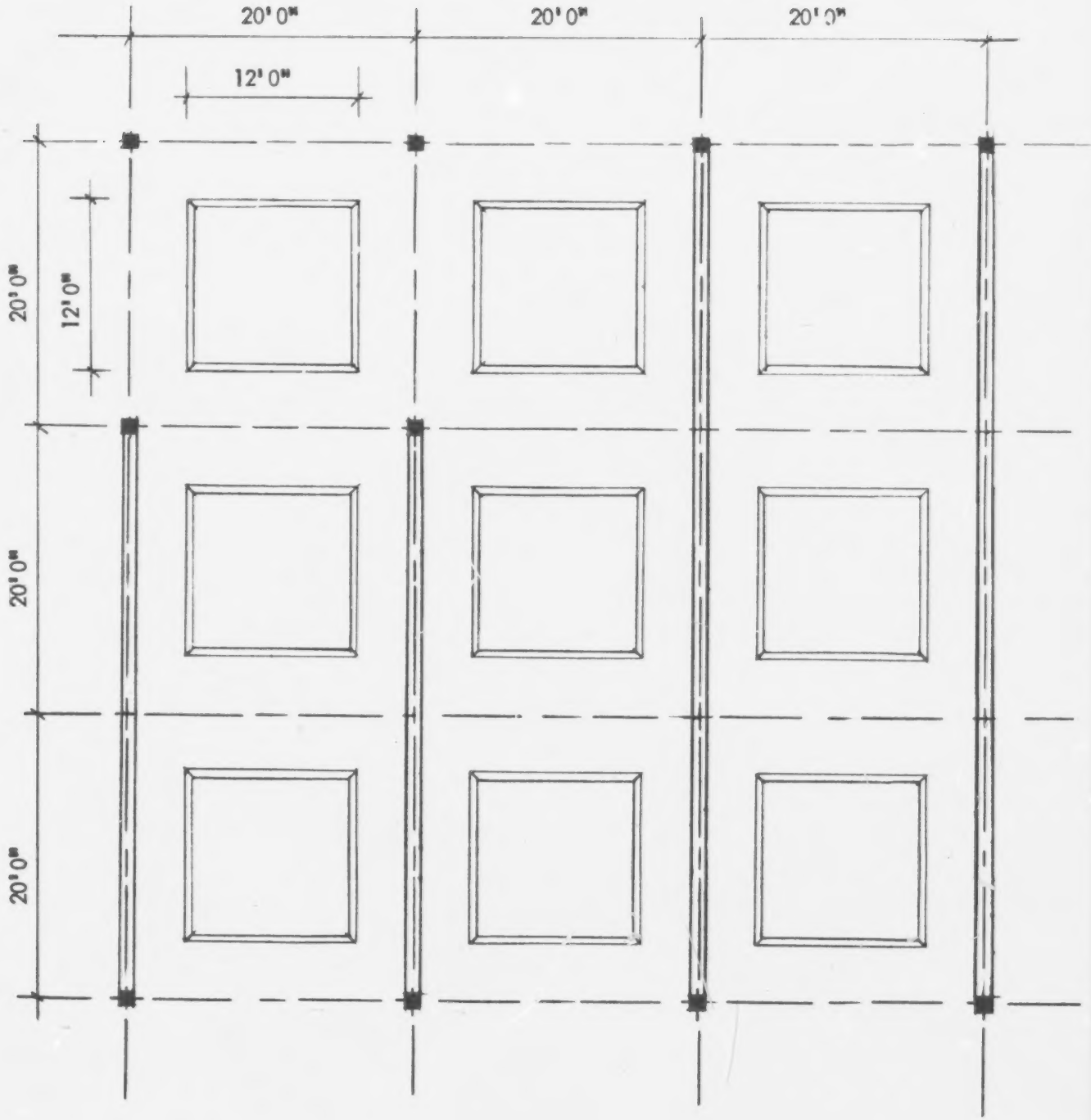
Canadian Johns Manville Co.Ltd - See Dominion Bridge presentation

Atlas Asbestos Co. Limited - See Dominion Bridge presentation

B.K. Johl Inc. - See Francon presentation

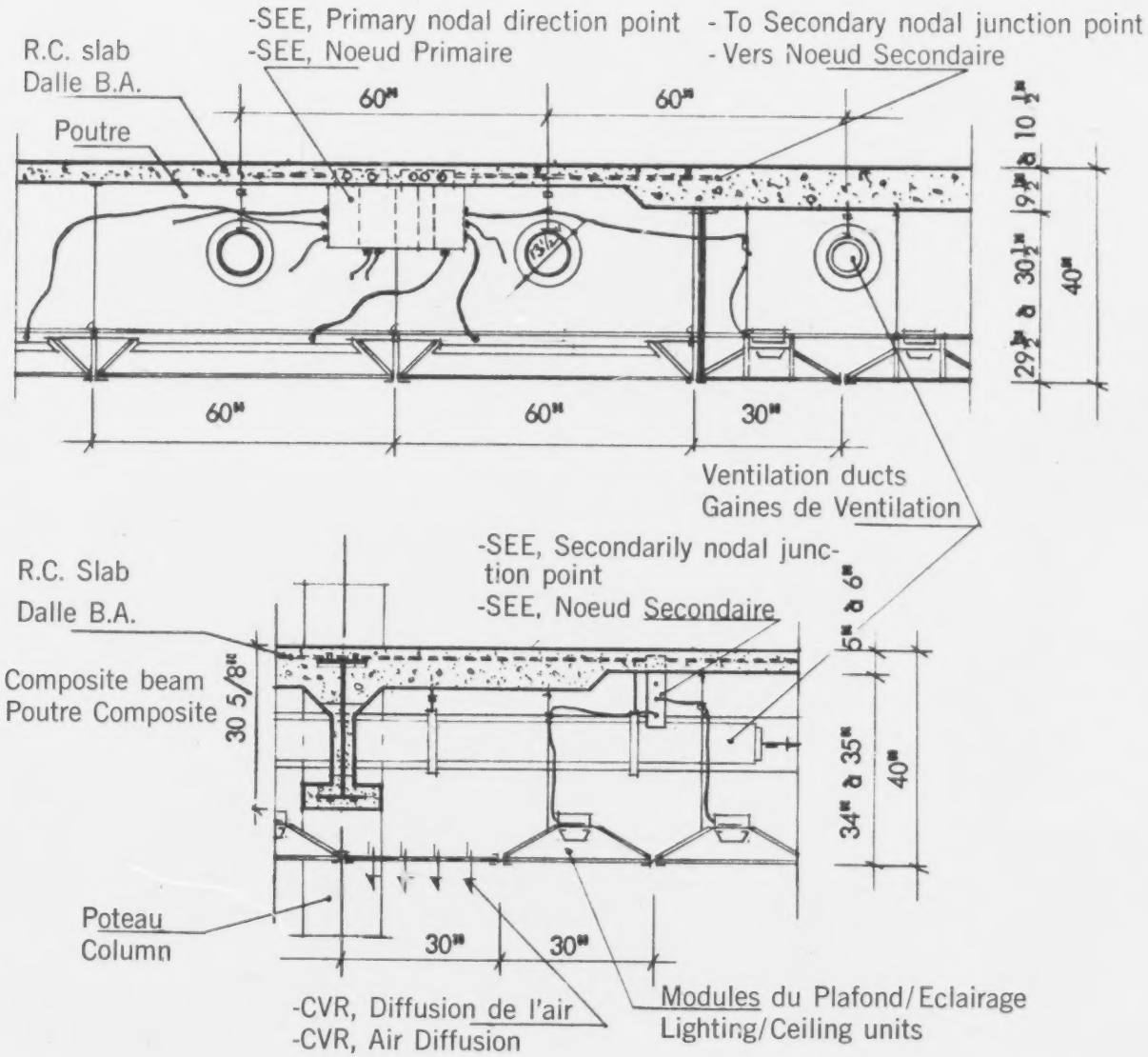


Groupe JANIN - Fig. 1 - Perspective générale du Système
JANIN Group - Fig. 1 - General perspective of System



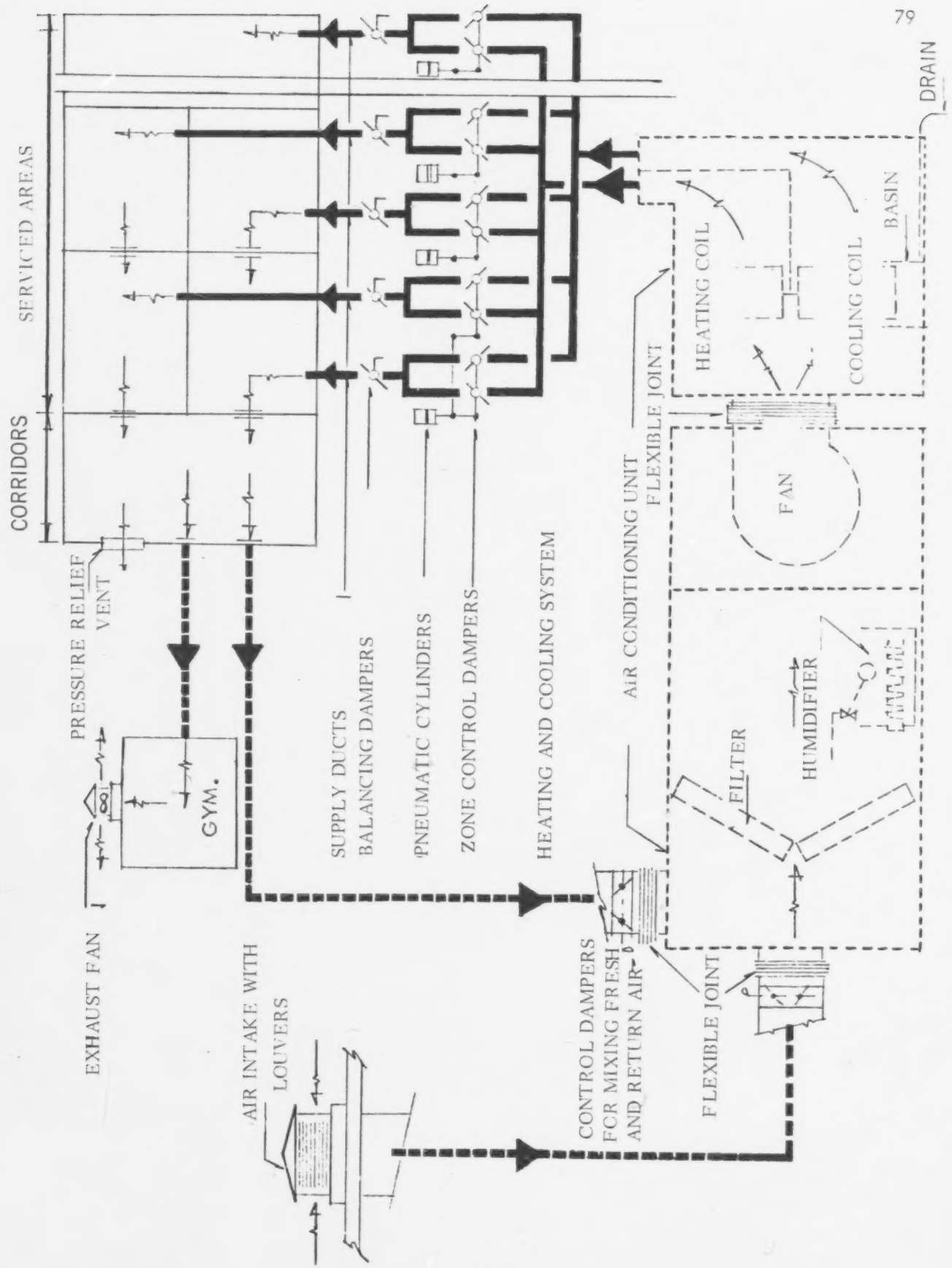

Groupe JANIN - Fig. 2 - Trame du Composant -ST
montrant la sous-face de la dalle, le défoncé de 12'0" x 12'0" et les poutres.

JANIN Group - Fig. 2 --ST Component: reflected plan of the Structural slab grid illustrating the underneath of the slab with its 12'0" x 12'0" recess and its projecting beams.




Groupe JANIN - Fig. 3 - Coupes sur le Sandwich montrant l'intégration des éléments

JANIN Group - Fig. 3 - Sections through the Sandwich illustrating the integration of elements




Groupe JANIN - Fig. 4 - Composant -CVR
Principe de fonctionnement du Système
JANIN Group - Fig. 4 - -CVR Component - Functioning principle of System

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e) Electric-Electronic Services Component (SEE) - Namur Equipement Ltée

General characteristics

The solution proposed is identical to that made for the Canron group with the exception that the supply and distribution networks from the Primary Nodes to the Secondary Nodes are buried in the upper part of the concrete of the slab.

### 3.4.5 Services SNC Group System

This system consists of five bids, -ST, -CVR, -PE, -CL and -SEE, all submitted by the same group (Surveyer, Nenniger, Chênevert Inc.)

This system is based on a prefabricated concrete structure (columns, beams and prestressed slabs).

This solution offers a sandwich thickness of 48" in all areas, except in the gymnasia (80' span) where the sandwich thickness is 40".

a) Structure Component (ST) - Services SNC Limitée

General characteristics

Types of slabs

The floor and roof elements consist of:

- -prefabricated hollow slabs, 40" wide and 10 inches deep for 20' spans,
- -prefabricated slabs with an inverted U form, 40" wide and 20 inches deep for 30' and 40' spans,
- -for 60' spans, 80" wide prefabricated "T" slabs, 24" deep at roof level and 26" deep at floor level; for 80' spans, same "T" slabs with a depth of 36".

Types of beams

Main, secondary and peripheral beams are prefabricated, with variable cross-sections with or without knees, according to requirements and designed to resist the loads imposed and torsion stresses induced.

Type of columns

The columns are of prefabricated concrete and variable dimensions; they are provided with a steel base plate allowing for levelling purposes as well as an anchorage system resisting lateral forces. For welding at joints, the reinforcing steel of the columns at each storey extends beyond the beam to the column immediately above.

Floor topping

The laying of the 2" cement mortar topping is provided for the grouting of joints and cavities between the slabs and beams as well as between beams and columns. This topping thus ensures over the whole framework, the monolithic properties required for the transmission of horizontal thrusts to the wind-bracing walls when required for the stability of the building.

b) Heating-Ventilation-Cooling Component (CVR) - Services SNC Ltée

General characteristics

The -CVR Component elements are totally independant of the -ST Component.

The proposed solution is based on a supply system at average speed and pressure, at constant temperature and variable volume.

The diffusers, like the return grills are linear and are integrated with the ceiling, using the same grid as the -PE Component (60" x 60").

Air is returned through the plenum: therefore the solution does not require return grills in the transom over the doors.

Automatic regulation is secured by a regulator which varies the air volume according to the individual requirements of each area.

c) Ceiling-Lighting Component (PE) - Services SNC Limitée

General characteristics

The assembly of the ceiling-lighting Component consists essentially of hollow modules (acoustic tile) 60" x 60" including lighting fixtures 48" long installed on 50% of the ceiling area.

This assembly is suspended by means of a rigid anchor tie.

d) Partition Component (CL) - Services SNC Limitée

General characteristics

The -CL Component consists of a system of gypsum panels covered in cold-laminated steel sheets cemented under pressure and insulated by means of a mineral fibre. Each of the enamel finish surfaces of a partition is demountable and independent, removed without affecting adjacent panels.

A standard panel measures 20" wide, 3" thick, and is adjustable in height by means of a telescopic head.

e) Electric-Electronic Services Component (SEE) - Services SNC Ltée

General characteristics

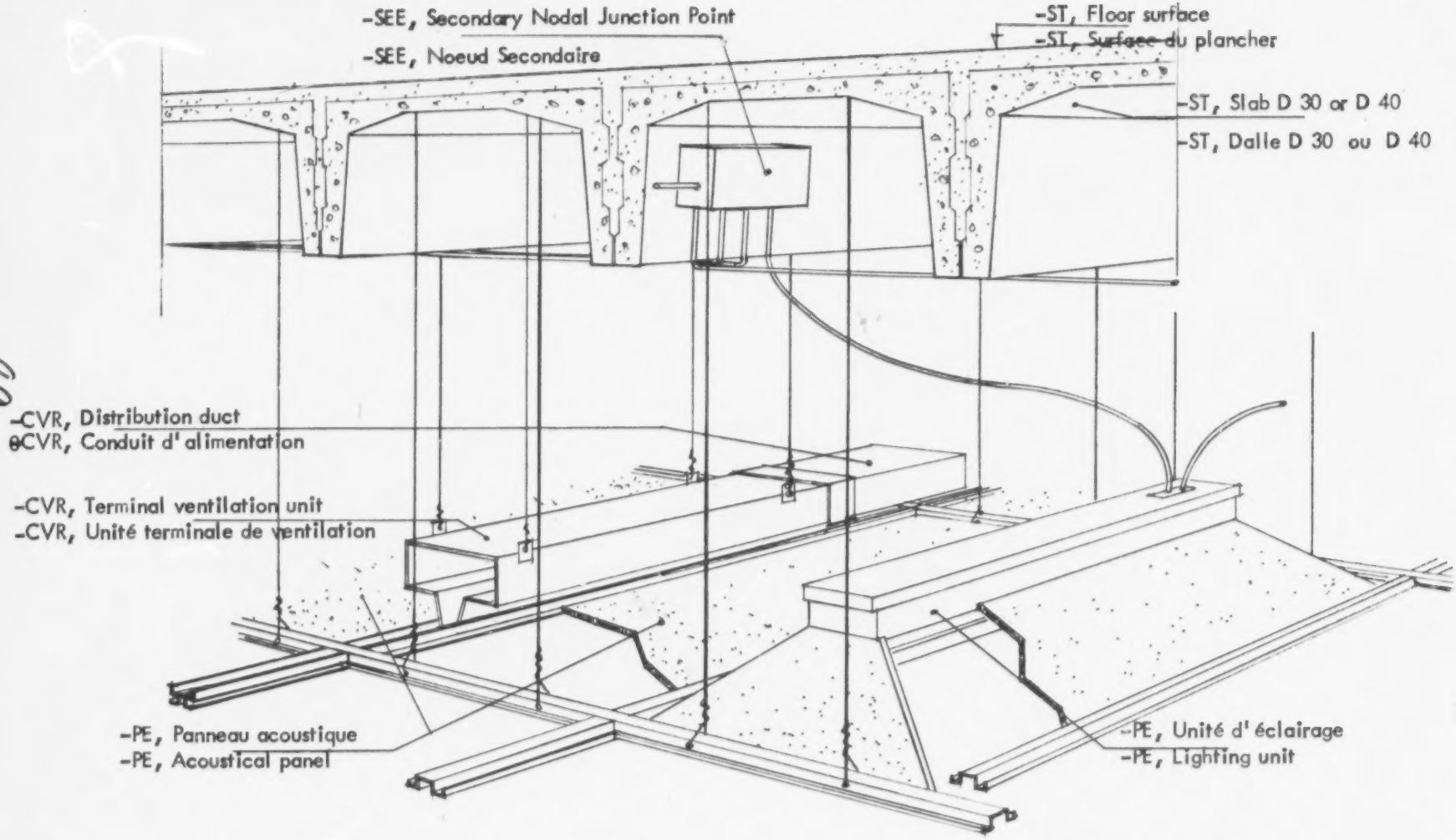
Electric and Electronic services suspended under the structure.

Use of connecting terminals inside the primary and secondary nodes for all the -SEE Services.

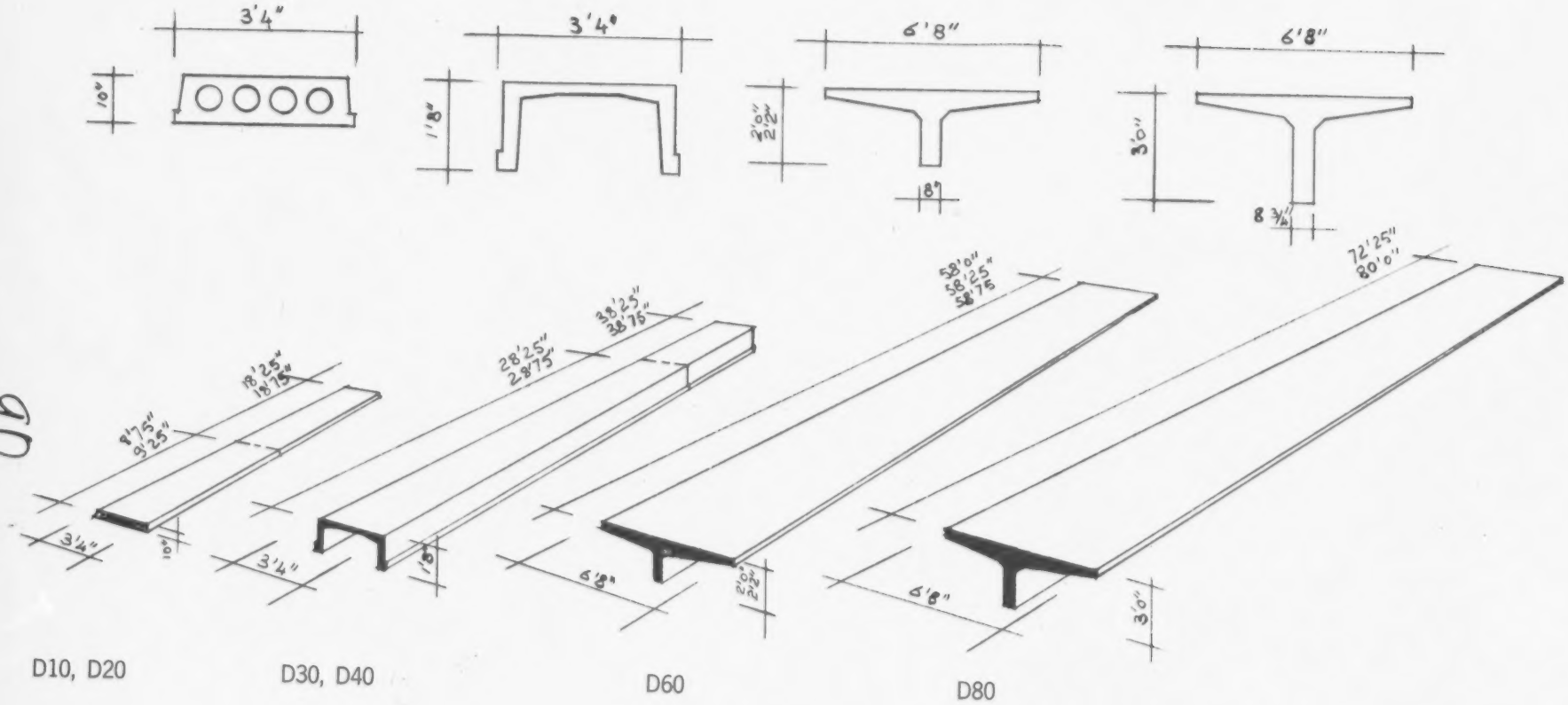
Low voltage lighting control system (24 V).

Network of nylon attachments installed on a 20' x 20' grid with the cables of each service retained directly by these attachments.

Installation of the columnettes on 20" sections of the partitions, both autonomous and integrated with the partitions.


-SEE, Secondary Nodal Junction Point
-SEE, Noeud Secondaire
-ST, Floor surface
-ST, Surface du plancher
-ST, Slab D 30 or D 40
-ST, Dalle D 30 ou D 40
-CVR, Distribution duct
-CVR, Conduit d'alimentation
-CVR, Terminal ventilation unit
-CVR, Unité terminale de ventilation
-PE, Panneau acoustique
-PE, Acoustical panel
-PE, Unité d'éclairage
-PE, Lighting unit

GROUPE SNC - Fig. 1 - Perspective du sandwich
SNC Group - Fig. 1 - Perspective drawing of sandwich

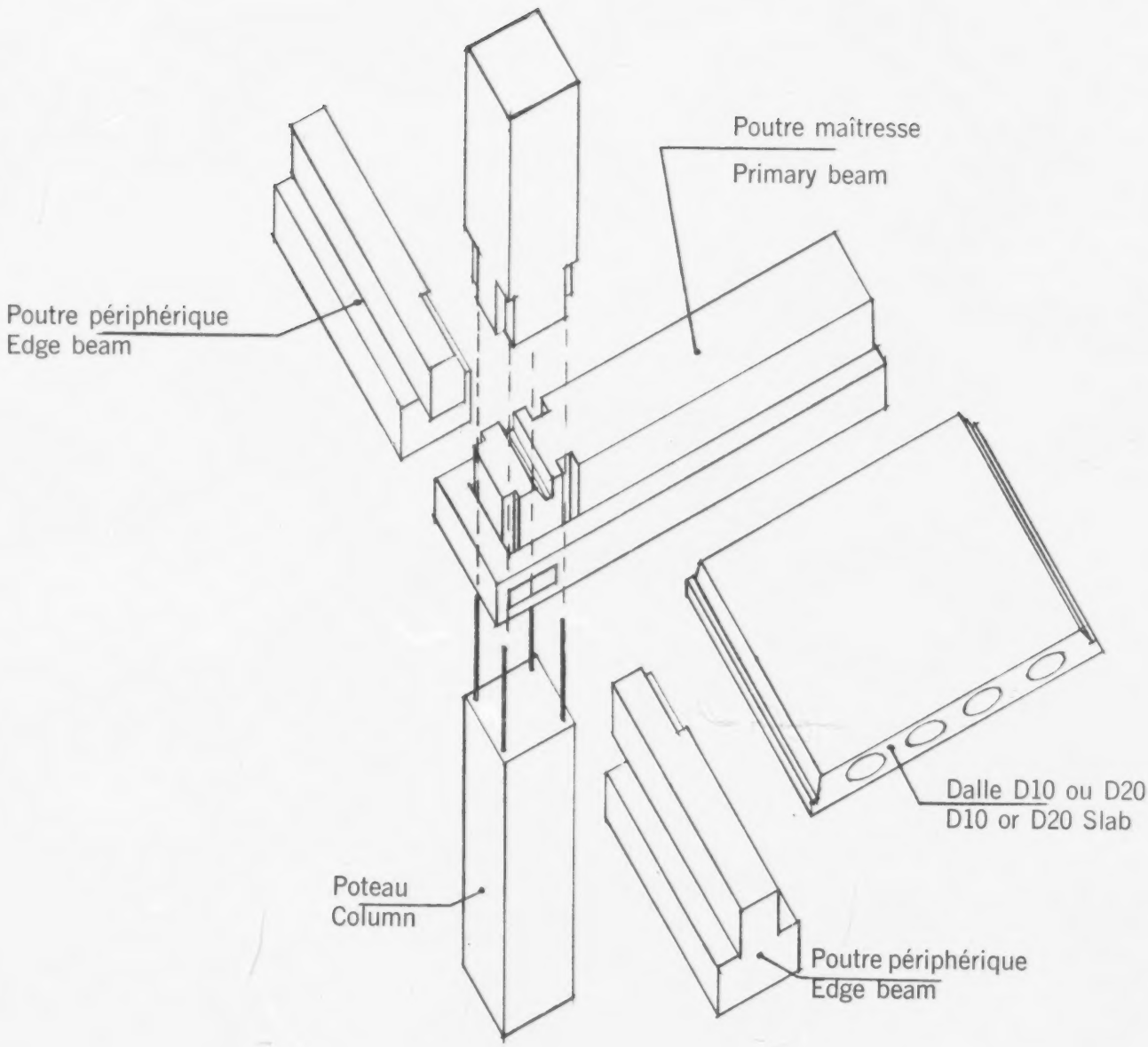



GROUPE SNC - Fig. 2 -

SNC Group - Fig. 2 -

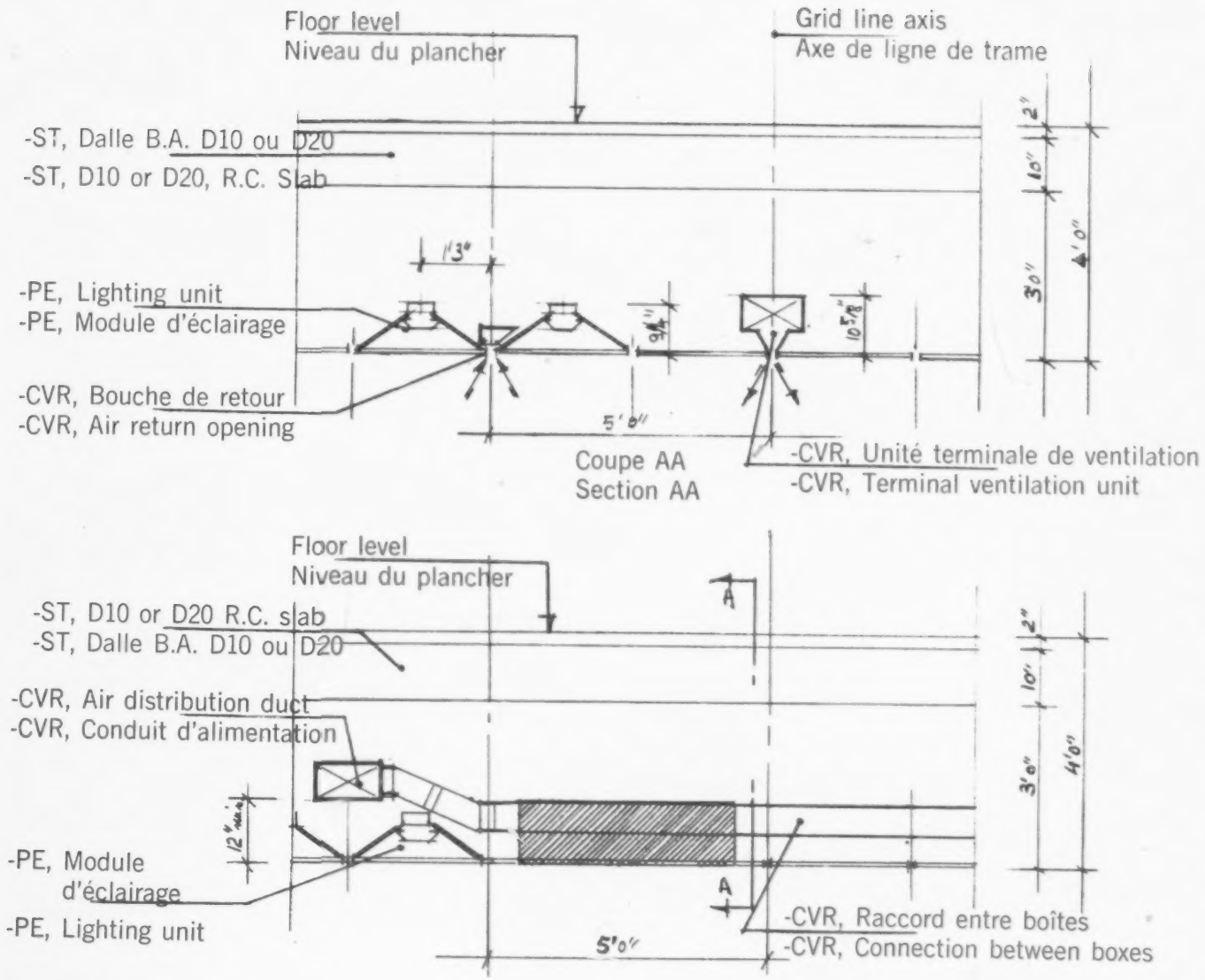
Types de dalles de plancher

Various types of floor slabs




Groupe SNC - Fig. 3 -
Vue axonométrique de l'assemblage périphérique
poteau, poutre maîtresse et dalle

SNC Group - Fig. 3 -
Axonometric drawing of peripheral column, primary beam and slab assembly




GROUPE SNC - Fig. 4 - Coupes sur le sandwich montrant l'intégration des éléments

SNC GROUP - Fig. 4 - Sections through the sandwich illustrating the integration of components

Appendix 1

## LIST OF SYMBOLS AND ABBREVIATIONS

| | |
|---|---|
| BEAM: | Building Equipment Accessories & Materials |
| MCSC: | Montreal Catholic School Commission |
| CL: | Partition Component |
| CVR: | Heating-Ventilation-Cooling Component |
| IRNES: | Institut de Recherches et de Normalisations Economiques et Scientifiques, Inc. (Montreal, P.Q.) |
| PE: | Ceiling-Lighting Component |
| (m): | International Module 4" |
| (M): | Horizontal Module of Integration 20" |
| DEQ: | Department of Education of the Province of Quebec |
| RAS: | Research in Educational Facilities |
| SEE: | Electric-Electronic Services Component |
| ST: | Structure Component |

Appendix 2

## CHOICE OF THE HORIZONTAL MODULE OF INTEGRATION OF 20"

So that this paper is complete further information concerning the choice of 20" for the Module of Integration of RAS Project is necessary.

Many studies dealing with this subject have been presented in successive reports to the Montreal Catholic School Commission by IRNES, but none of these reports relate specifically to the choice of modules. Amongst those reports, are the following:

-"Expériences Similaires" (SEF Project, Toronto) - (URBS and SCSD Projects in California, etc.)

-"Etude des Critères de Modulation"

-"Etude sur les possibilités des Composants"

During these studies, the following has been considered:

.1 the different locals to be formed so to correlate with pedagogical requirements taking into account the different standards from the MEQ dealing with area vs number of pupils,

.2 the types and degrees of flexibility of these locals and different possibilities of arrangement as dictated by contemporary pedagogy,

.3 the needs for these requirements,

.4 the possibilities of present technology, in other words the effects of different modules of integration on the Components, its relation with different grids of the Components, the module and the possibilities of Components (design, manufacturing, transportation, erection, installation...),

.5 restrictions imposed on the -ST Component Bidders, depending on the basic material used; this 20" horizontal module of integration allows indeed the use of a Structural Grid other than the 60" grid (for example: 40 or 80 inches),

.6 the importance of coordinating with SEF Project in Toronto that has selected a module of 5' -0" x 5' -0",

.7 the mathematical relationship between design and reference grids that is at the scale of materials (natural series, arithmetic series of reason 2 and 3, geometrical series of reason 2 and 3...): preferred dimensions that had to be between 20" and 64" have been established according to the dimensions of locals and the scale of materials,

.8 the advantages of a square orthogonal grid in relation with other possible grids: 45° lines permits the formation of octagons, 60° lines permits the formation of hexagons and equilateral triangles, and combinations of 45° and orthogonal lines.

Following these different studies, a module of 20" was selected. This module provides sufficient flexibility for the various spatial requirements;

-in addition, it conforms to the grids of all the Components in the System;
-different types of construction systems are compatible with it;
-its permits a certain coordination of RAS Project with SEF Project because 3 x 20" equals the 5' module of the SEF Project.

Furthermore, URBS Project uses also a 20" module of integration. Therefore, this module might also be used for residential construction.

Appendix 3

## LIST OF PARTICIPATING COMPANIES

American Air Filter of Canada,
400 Stinson Street,
Montreal 9, Quebec, - Canada

Atlas Asbestos Co.,
5600 Hochelaga Street,
Montreal 5, Quebec, - Canada

Bedard-Girard Ltée,
117 Lagauchetiere Street West,
Montreal, Quebec, - Canada

Canadian Johns-Manville Co. Limited,
4999 St.Catherine St, West,
Montreal 6, Quebec, - Canada

Canron Limited,
1121 Place Ville Marie,
Montreal 2, Quebec, - Canada

Dominion Bridge Company Limited,
Postal Box 280,
Montreal 3, Quebec, - Canada

Electrolier Corporation,
8501 Jarry Street, East,
Montreal 5, Quebec, - Canada

Francon Limited,
3701 Jarry Street, East,
Montreal, Quebec, - Canada

Janin Construction Limitée,
7085 Chemin Cote des Neiges,
Montreal 16, Quebec, - Canada

B.K. Johl Inc.,
1200 Jules Poitras Boulevard,
Montreal 9, Quebec, - Canada

Lennox Industries (Canada) Limited,
400 Norris Glen Road
Etobicoke, Ontario, - Canada

Namur Equipement Limitée,
3901 Jean-Talon Street, West,
Montreal 16, Quebec, - Canada

Services SNC Limitée,
1550 de Maisonneuve Boulevard,
Montreal 25, Quebec, - Canada